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Britain's National Economy

THOSE who have given careful study to Britain's national economy will have realised that the balance of payments remains the main economic problem this year and probably for many years to come. There are two main tasks: first to close the gap in the dollar accounts of the sterling area, and the second to maintain a reasonable balance in the external accounts of the United Kingdom with the world as a whole. As a partial solution it has become increasingly necessary to increase home production of dollar-saving foods and materials; more exports to American countries; the diversion of purchases from hard-currency to soft-currency sources; the encouragement of dollar-earning activities in the Commonwealth and Colonies; and the increase of exports to sterling area countries likely to help in the saving of dollar expenditure.

It will be remembered that the main tasks for last year were: to raise production and productivity and bring down costs; to continue the battle against inflation; and to continue to reduce the gold and dollar deficit, particularly by expanding exports to Canada and the United States. According to the *Economic Survey for* 1950 total production increased steadily during 1949 and substantial advances were made in almost every part of the economy. Although there is very little firm evidence about general changes in productivity, and crude comparisons of production and employment indices provide only a rough guide, the figures given for a limited field indicate an increase in output per man. On the question of balance of payments, 1949 proved to be a critical year. During the first half of the year the gold and dollar deficit increased, due largely to a falling off in the dollar earnings of the sterling area. A repression in United States industrial activities encouraged her manufacturers to draw on their stocks. Wide expectation that the pound would have to be devalued led sterling area importers to anticipate, and foreign importers to delay, purchases and payments. The combined effect was a greater deficit than would be met by the special assistance received and emergency measures were adopted to check the depreciation and ultimately, to prevent the possible exhaustion of reserves, the value of the £ was reduced 30%. Although about three-fifths of the loss of reserves during the summer had been recovered by the end of the year, the permanent effect of devaluation on dollar-earning capacity will become more apparent during the present year.

The experience of 1949 emphasises the further need for increased production of the right kinds of goods, but increased productivity, which is so essential, must not be accompanied by higher costs, it must be the result of increased efficiency. Higher costs and prices will obviously endanger the opportunities which devaluation has created and make more difficult the task of meeting increasing competition from exporters in a number of non-dollar countries. The Government's *Economic Survey* again emphasises that the competitive power of Britain is her main hope of progress and to sustain this restraint in wages demands must continue. It might have been expected, however, that the Government would do its utmost to make the acceptance of a wage-freeze palatable, instead, the cost of living is steadily rising. And the imposition of a 33⅓% purchase tax on commercial vehicles and a further 9d. a gallon tax on petrol will inevitably increase transport costs; certainly these will not assist the competitive power of industry.

Sir Stafford Cripps was very lucid in his Budget speech, both in the House of Commons and in his broadcast, and was very pleased with the fiscal structure he has built up over the last three years to sustain the present internal economic situation. He is dogmatic in asserting that the country can maintain indefinitely a level of employment, which most economists regard as overfull, and further that the State can spend indefinitely 40% of the national income in the form of taxation. But Britain can never be self-sufficient, much of the food and most of the materials she needs must be imported and paid for with her products. Full employment, therefore, depends upon world conditions and not on a taxation policy of any Government. Trading conditions must be favourable in other parts of the world and Britain must be in a position to trade with the right kind of goods, at a competitive price, and with particular attention to delivery dates. Not only are producers in this country excessively taxed in competition with other exporting countries, but they are hedged with so many restrictions that, when sanction is ultimately given, the required delivery time is far exceeded.

It is very doubtful whether Britain's man-power and resources have yet been fully developed to meet the changed conditions of the post-war world. Too high a proportion of the available man-power is absorbed in administrative duties associated with various Government Departments and, as such, are unproductive. The need is all the greater, therefore, for hard work and creative effort and for the establishment of conditions that will induce men and women to give of their best. But only a prosperous world, able and willing to buy her products will permit Britain to restore her finances so that minor fluctuations in world trade would not seriously inconvenience her economy. The devaluation of sterling designed to force the pace of the dollar export drive, when a repression in United States trade was apparent, gave Britain an immediate competitive advantage. That method offers no permanent solution and cannot again be used to cushion the effects of a crisis. With favourable world conditions only hard work can assist the recovery of Britain and the restoration of her national economy.

The Drop-forging Industry

Productivity Team's Report

A FURTHER report has been published as a result of a study of American production methods. It deals with the drop-forging industry and presents the views of a team which has made a tour of the drop-forging industry of the United States of America under arrangements made by the Anglo-American Council of Productivity. The purpose of this Council is to promote economic well-being by a free exchange of knowledge in the realm of industrial organisation, method and technique, and thereby to assist British industry to raise the level of its productivity. The present report brings into direct comparison for the first time the methods of drop forging in America and in Britain. Many important conclusions are drawn and they lead to recommendations for the development of short-term and long-term policy in British drop forges ; there are 21 illustrations of American techniques.

The team, which was composed of equal numbers of representatives of management, technicians and operatives in the industry, believes that the greatest factor in achieving high productivity in America has been the acceptance by both workpeople and management of the principle that every blow which the forging unit can deliver should be utilised for the performance of useful work. Maximum machine utilisation is considered to be the greatest single contribution which can be made to higher productivity with existing plant. To make the fullest use of the machine, therefore, the hammer man, or press operator, should be so serviced that he performs only productive work. Ancillary tasks, like fetching bars or pieces from the furnace or passing forgings for clipping should be performed by a helper or by mechanical aids. Where the physical effort required of the forge man and his crew is too much to be maintained for an extended period arrangement is made for an auxiliary crew to take over.

The question whether the technique adopted in American drop forging gives a greater output than in Britain is a difficult one to answer and the Team has guarded itself against the danger of generalisations by making comparisons with the aid of job sheets. Basing its finding on a comparison of some twenty forgings, the Team says the American forge will produce many more forgings per hour than a corresponding British forge. This finding is preceded by the statement that general comparative figures necessarily conceal differences in design (whether simple or elaborate) and in the size, weight and finish of forgings. Recognising the existence of these differences the Report says that it is still possible to measure broadly the productivity of the two industries. One of the measurements of production quoted by the American Drop Forging Association is the pounds weight of drop forgings produced per man-hour over a defined period. Such figures covering a number of years are available in the United States. If the British industry wishes to ascertain its own productivity it is only necessary to compile similar returns and then, with co-operation on both sides of the Atlantic, a direct comparison could be made between similar sizes of forges in the two countries.

Copies of this Report, price 2s. 3d., may be obtained from : The National Association of Drop Forgers and Stampers, Grove Hill House, 245, Grove Lane, Handsworth, Birmingham, 20 ; or The Anglo-American Council on Productivity, 21, Tothill Street, London, S.W.1.

In America the drop forger tends to concentrate on certain lines of production, say, the manufacture of crankshafts or golf club heads, and is not afraid to hand on to his customer the benefits of his knowledge and technique, often in the form of a lower price. There is in the British industry an obvious field for specialisation to give the buyer a better product at lower price. The British automobile manufacturer has large orders to place—large enough to justify mass-production methods. If specialisation is adopted mass-production methods can be used and productivity increased.

Discussing quality and the finish of forgings the Report points to the realism of the Americans who say that what is good enough for the job *is* good enough, and it suggests that in some cases in Britain the finish of parts is excessive.

High productivity is promoted in America by means of incentives to the worker who knows that if he increases production he will gain in purchasing power. The fear of replacement if he does not reach the accepted standard is an indirect incentive. The key to the situation is the purchasing power of wages and in Britain this is limited by scarcity of goods in the shops, high prices, the purchase tax and high income tax. Serious attention should be given to these disincentives. Where higher production is achieved with existing plant through the efforts of the workers, piece-work rates should be maintained. A simple wage system is an advantage and the British wage system might well be overhauled.

Among other items included in a short-term policy for higher productivity are : Improvement of the standard of housekeeping in forges ; research into the " shearability " of steel, America drop forges shear steel up to 4 in. square ; more attention to ventilation in hot weather and the use of " man-cooling " fans ; the adoption of larger and better furnaces ; trial installations of high-pressure water jets and other devices for descaling ; use of larger hammers requiring fewer blows to produce forgings, reducing wear and tear on plant, kinder treatment of dies and higher productivity ; development of mechanical handling ; wherever possible die lubricants should be eliminated to increase die life and improve working conditions ; multi-impression dies should be used wherever possible ; more attention should be given to the good finish of die impressions ; attention should also be given to the use of split clipping beds ; increased use of cold clipping ; research into suitable steels for clipping tools, into design of tools and the introduction of new methods ; improvement of maintenance, especially the speed of running repairs ; standardised tools and equipment within factories ; design and planning staff should be kept informed of the cost of equipment and materials so that they may the better devise the most economical methods and tool designs ; and most important of all, development of safety consciousness through propaganda and co-operation.

The Team judged the standard of living of the American hammer man to be higher than the general average of other workers. He was earning the equivalent of from £20 to £30 a week and other grades of forge workers were paid *pro rata*. One hammer man said he regularly earned up to £45 a week working five days of nine hours each. Yet—and this is a comparative measure of productivity—the price per piece received by this operator was about one-half of that received by his opposite number in Britain for producing a similar part.

ALUMINIUM BRAZING

By T. J. Palmer, A.M.I.W.

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In the fabrication of aluminium alloys, increasing use is being made of a "brazing" process using an aluminium-silicon eutectic alloy as the jointing material. After a brief discussion of the relative merits of soldering, brazing and fusion welding, the author discusses the brazing operation in some detail.

THE term "Aluminium Brazing" refers to a now widely used process of joining aluminium and selected-type wrought alloys at a temperature substantially below the melting point of pure aluminium; it has all the characteristics of any other form of brazing. The brazing medium normally used is the well known 10–12 per cent. aluminium-silicon alloy melting at approximately 580° C., and commercial applications of the process have been assisted materially by the development of improved and specially compounded fluxes. It is interesting to reflect, however, that whilst "brazing" of aluminium is comparatively new, aluminium-silicon alloy filler metal has been in general use for low-temperature welding of aluminium-alloy castings for some considerable time.

Hitherto, the alternative to welding has been soldering which, unfortunately, is not easy to carry out satisfactorily. It is not very popular, in this country at least, and although there are many different types of so-called "solders" for aluminium, few are of any great importance. Moreover, the corrosion of soldered joints in aluminium remains a real problem. The subject is a special and somewhat difficult one, and it has often been said that the easiest way of soldering aluminium is to weld it. Now it might be said that the easiest way of welding it is to braze it. . . . The brazing method is readily adaptable to line work and to quantity production; the cost is lower, the work neater, and sections well below the safe limit for welding can be satisfactorily brazed.

Aluminium-fusion welding has, of course, attained a high degree of usefulness during the past two decades, but there are certain inherent disadvantages:—

(*a*) Considerable skill is required, particularly with thin sections—i.e., below 18 S.W.G.

(*b*) There is a danger of flux becoming trapped in the joint, particularly with fillets which, though convenient to adopt in fabrication, are debarred from the designer for this reason.

(*c*) It is difficult, frequently impossible, to join thin sections to very thick ones without serious undercutting, or melting down of short extensions and upturned pieces.

These difficulties are eliminated with aluminium brazing which requires much less skill in operation. In fusion welding the sharpness of edges and corners may easily be destroyed but, when the brazing procedure is employed, the melting point of the parent metal is never reached. Undercutting and the burning of holes are therefore impossible, and flux cannot remain trapped because it is swept out automatically by the molten brazing metal as it flows through the joint. Brazing has thus extended considerably the present field of joining, opening up new ones at the same time.

Brazing

The brazing of any metal or alloy depends upon three main factors: (*a*) Clean work; (*b*) a good flux; (*c*) a low-melting-point filler alloy. It involves, in principle, heating the workpiece to a certain minimum temperature, at which both flux and brazing medium are quite fluid and able to flow easily and quickly into the desired groove or space by capillary action. The parent metal must remain rigid and unmelted throughout the process, so that good brazing is not possible unless a reasonable temperature difference exists between the melting point of the parent metal and that of the brazing metal. Theoretically, a few degrees is sufficient, but practical considerations are influenced by "sagging," "blistering," and other effects which often precede fusion, and it is usual to specify about 25°–35° C. as a safe temperature difference between the two; the greater it is, the easier and more foolproof the operation of brazing becomes. Consider for a moment the case of steel melting at 1,500° C., using the following brazing metals: Silver solder (m.p., 630° C.); brazing brass (m.p., 850° C.); and copper (m.p., 1,083° C.). In each case the margin is very wide and corresponds to a melting difference of 870° C., 650° C., and 417° C., respectively. A narrower margin is provided when copper is brazed with brazing brass, but the figure of 233° C. is obviously very safe. Substituting 70/30 brass for copper, it is lowered still further, and when 60/40 brass is the metal being brazed the operation becomes a critical one, since the metal may collapse, or become accidentally melted—especially with torch brazing. Closer temperature control is possible in the case of furnace brazing and it is not unusual to find 70/30 brass being brazed with the 60/40 material, but the melting margin between the two is necessarily a close one requiring a certain amount of operational care.

Similar conditions exist in the case of "Aluminium Brazing," where there is a relatively small temperature difference between pure aluminium melting at 659° C. and the aluminium-silicon alloy brazing metal at 580° C. —yet brazed joints are easily possible in commercial purity aluminium. Bearing in mind that the melting point usually falls with alloy additions, it becomes evident that certain alloys of aluminium will melt at temperatures inconveniently close to that of the brazing metal, and temperature control in brazing may thus become more and more critical until a point is reached where the process is no longer practicable. Also, most aluminium alloys have a "pasty" range between melting and freezing, and the effect of heating within this range will produce partial melting, burning, or blistering, so that a second requirement for satisfactory brazing is for the melting point of the brazing alloy to fall below the solidus of the parent metal. Many of the aluminium

casting alloys have wide freezing ranges and low-melting features, and their brazing is still largely in the development stage. Brazeability may be influenced by considerations other than melting point, notably constitution of the alloy and the nature of oxides formed during heating. Thus the presence of magnesium, above about 2%, will tend to make brazing difficult by introducing a more refractory film for which the ordinary brazing fluxes are insufficiently active.

Brazeable Materials

Easily brazed materials include pure and commercially pure aluminium, and alloys of the A.W.3 specification (Noral 3 S ; BA. 60 ; Hiduminium 11 ; Kynal PA. 19) ; flow of brazing metal is extremely rapid in this case. Those of the A.W.10 group (Noral 51 S ; BA. 25 ; Duralumin H ; Hidiminium 44 ; Kynal M. 38) are also satisfactory, the influence of magnesium in amounts ranging from 0·5 to 1·5% having only a minor effect upon flow. Difficulties arise quickly upon entering the A.W.4 specification range (Noral M. 57 S ; BA. 21 ; BB. 2 ; Hiduminium 22 ; Kynal M. 35/1 ; MG. 2) owing to the magnesium content running at between 1·5 and 2·5%. They are brazeable, however, if the oxide film is first removed, and brazing carried out immediately afterwards. The sluggishness of the brazing metal and the increased time of brazing is quite marked, nevertheless, and A.W.4 can be taken as somewhat of a border-line specification. Brazing is not practical with higher magnesium contents, using standard flux mixtures, and the following alloys should be avoided: A.W.5 group (BA. 27 ; BB. 3 ; Hiduminium 33 ; Kynal M. 35/2 ; MG. 3) ; A.W.6 (BB. 5 ; Kynal M. 36 ; MG. 5) ; A.W.7. (BB. 7 ; Kynal M. 37 ; MG. 7). Those of the A.W.2 specification are obviously unsuitable, due to their high silicon content and low-melting characteristics. Copper does not affect brazing to any extent, and most ordinary alloys of the duralumin type are brazeable. In this case, however, other considerations must arise since the beneficial effects of heat treatment and previous work are entirely removed by brazing. The list is, therefore, necessarily limited, and the expansion of the process must centre primarily around further research concerning fluxes of greater chemical activity, and brazing metals of still lower melting point.

Brazing Alloys

Alloys having melting points considerably lower than that of C.P. aluminium and the usual range of aluminium alloys can be obtained by the addition, to pure aluminium, of zinc, copper, silicon and nickel, the possible combinations being many. The practical aspect of "brazing" is influenced chiefly by melting point and fluidity and, to a lesser extent, by strength characteristics and ductility. The latter property will, of course, be of fundamental importance in furnace brazing, where material must be made available in different forms for preplacement in the joint. Corrosion resistance is naturally a factor of importance, and as articles likely to come in contact with food are frequently required to be brazed, this in turn will impose certain limitations upon the alloying elements which may be used. The most satisfactory combination of these various requirements is provided by the straight aluminium-silicon group of alloys which are now widely used for brazing. It is seen from Fig. 1 that the addition of silicon to aluminium results in a simple eutectiferous system giving, according to the position relative to *XX*, either the primary aluminium solid solution + aluminium-silicon eutectic, or primary silicon + aluminium-silicon eutectic. Those used for brazing generally lie to the left as indicated by the accompanying photomicrographs. Silicon effects a marked lowering of the melting point of pure aluminium from 659° C. down to 577° C. at 11·6% silicon, or about 7° C. for each 1% silicon added. Any aluminium-silicon alloy falling within the region *ABCD* is technically suitable for brazing, although with the 5% commercial alloy the practical brazing range is seen to be somewhat narrow. The increased fluidity, shorter freezing range, and low-melting features of the richer alloys is obviously an advantage—the 10–12% alloy having been generally adopted. It is clean, has a high degree of fluidity, a negligible freezing range, low shrinkage solidification, and is both dense and non-porous after melting. Its relatively high hardness is due to that inherent in the aluminium-silicon eutectic.

Fluxes

The purpose of the flux is to detach the refractory oxide films as rapidly as they are formed and, if this is done effectively, wetting can then ensue allowing brazing to take place. A number of different mixtures are at present on the market, and whilst most are suitable for welding, few are suitable for brazing. Brazing fluxes melt around the 540° C. mark—a temperature which forms a useful guide or tell-tale during torch brazing operations, indicating that a further small temperature rise corresponds to the flow point of the brazing metal. In this way, temperature control can be measured to quite close limits and the possibility of overheating and accidental burning of the parent metal is very remote.

For the flame brazing of open seams, the flux is used dry, sprinkled over the heated metal, or, if preferred, via the heated end of the brazing rod. Pastes made up with water or alcohol, preferably the latter, are used in most other cases. With alloys, and also in cases where there is some difficulty in cleaning the reverse side of the joint, the application of a paste of about the same consistency as cream is recommended. Perfectly clean containers should be used when mixing the paste ; iron and steel ones are to be avoided. It is as well to remember that the dry flux is very hygroscopic, more so than the welding type, and for this reason people who do a limited amount of aluminium brazing might be well advised to purchase in half-pound tins, upon grounds of economy.

Preparation for Brazing

In all cases the parts should be degreased either by washing in hot, soapy water, or with trichlorethylene or benzine. Paint, dirt and protective coatings of any type must also be removed locally, either chemically, or by wire brushing. The oxide layer ordinarily present on the surface of alloys can cause quite a lot of trouble by limiting spread of the brazing metal, and pre-cleaning with steel wool or by wire brushing should be standard practice with these materials. It cannot be too strongly emphasised that, unless the joint surfaces prior to brazing are satisfactory as regards surface tension, flow cannot occur, and that is why pre-cleaning of parts is so necessary—more so with alloys, and particularly in the presence of even small amounts of magnesium. Commercial purity metal, if new and bright, requires no preparation other than degreasing. With small parts

which are very badly stained it may be necessary to use caustic alkali, and to rinse afterwards in plain water, but this treatment is very drastic and must be used with every caution. Other methods are generally to be preferred.

Tee fillet and lap joints, which are considered unsuitable for welding, are quite suitable for brazing, but with laps the amount of overlap should be kept small. Most of the ordinary mechanical set-ups in general use for the brazing of other materials are also suitable for aluminium brazing. Lock, or folded seams are suitable, and butt joints of both square edge and corner type are used, but the fluidity of the molten brazing metal makes control more difficult with these joints and "backing" is frequently necessary.

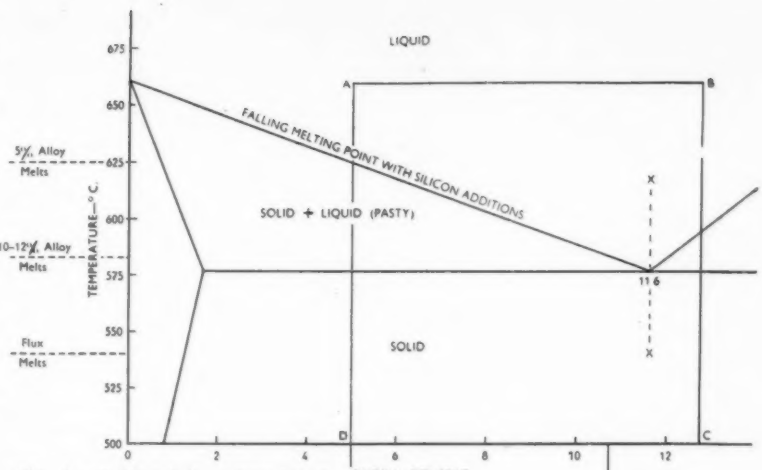
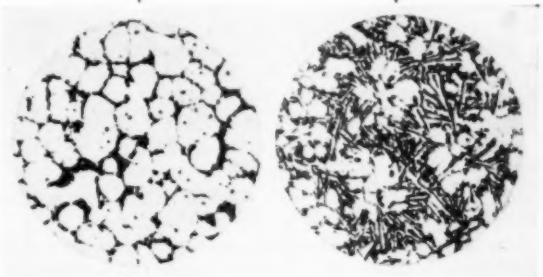


Fig. 1.—"Aluminium-brazing" diagram

With regard to clearances, molten aluminium-silicon alloy brazing metal appears to be more viscous than most other brazing metals and for this reason it is recommended that slightly larger clearances be allowed; it is also an advantage to cut a small lead groove wherever possible. To some extent clearance is governed by the type of alloy being brazed, especially where pick-up may affect the issue. Tight fits must not be used and, as a very general guide, clearances varying from 0·003–0·010 in. are satisfactory for short runs of metal, but may be increased to as much as 0·025 in. in the case of long laps. A minimum clearance will be required when flow is acting against gravity in order to utilise fully the forces of capillarity. Sheared edges should be trimmed quite square, and a good fit of relative parts is of fundamental importance in the ordinary way. It is, for instance, quite impossible to braze satisfactorily where there are large gaps across the joint, and if this cannot be avoided one should "weld" using a different type of filler rod.

The brazing alloy can either be preplaced as rings, washers, strip or wire, in suitably prepared grooves or openings, or can be applied manually by the operator, at the brazing temperature, using a rod of alloy and a suitable manipulative technique. When material is preplaced without any means for holding it, there is a risk of it getting washed away from the joint area when the flux becomes fully molten; there is, also, some tendency towards "balling-up," during the initial stages of melting, resulting in uneven distribution of brazing metal in the joint. The balling-up effect may be due to the high surface tension present immediately prior to "flooding," peculiar to aluminium, and caused by the stubborn nature of the oxide even in the presence of a very active flux.



5% Alloy **10—12% Alloy**
As Deposited.

Torch Brazing

Torch, or flame, brazing with the oxy-acetylene welding blowpipe is the usual method of brazing aluminium. Other flames are also used, including oxy-coal gas, hydrogen, propane and even air-coal gas, but the oxy-acetylene is the fastest and most localised of them all. Slower heating with flames of lower temperature reduces the danger of local fusion, but their greater heat spread causes wider heat effects and softening, whilst the possibility of mass collapse of the part at the brazing temperature is actually increased. A further point in favour of oxy-acetylene is that the time factor in brazing is itself important. Holding work set up for brazing, at temperatures just below the brazing range, has a deleterious effect upon both flux and brazing alloy which, in certain circumstances, will make brazing impossible, even when the normal temperature has been attained.

For the protection of the operator's eyes, blue glasses will be found more suitable than green, since they filter off the yellow glare emitted by sodium compounds in the flux, but they ought not to be too dark. Grade G.W.I/B.S.S.679 (blue) are particularly suitable. A neutral or slightly reducing flame is usual, but so long as conditions do not become actually oxidizing, flame adjustment is not critical. Gas pressures should be low, and the nozzle size can be the same as would normally be used for fusion welding the same section. Again it is not critical, since the primary zone of the flame is not fully utilised.

Brazing procedure is very simple and with small parts, where the work has been pasted with flux and the brazing alloy preplaced in the joint, it is only necessary to heat up the part with the envelope of the flame until first the flux and then the rod, melt, when the action of brazing is performed automatically. The operator will be guided by changes in appearance of the flux film which first bakes hard, then darkens in colour, and finally melts. Further heating causes the now liquid

flux to thin out and to cover effectively the entire joint area by reason of its own spreading power—a stage which corresponds approximately to the melting point of the brazing alloy. When using the flux dry, an adhering tuft is picked up on the end of the heated brazing rod, and as the component parts are heated up, a check is made at intervals by "wiping" the joint area gently. Melting of the flux is the tell-tale indicator that the brazing temperature is near, and the rod is actually added when the flux has thinned out and is fully mobile over the work. Melting is controlled by the technique of the operator who must maintain the brazing heat and give equality of heating to each member until flow is complete, and the whole joint properly filled with brazing metal.

The technique of torch brazing open seams is easily acquired, and the operator should try to develop a short, stroking movement over the seam with the brazing rod and to synchronise with it a similar movement of the flame following up immediately behind. Where two sections of different thickness are being brazed the operator will naturally concentrate preferentially upon the thicker gauge. When using oxy-acetylene, flow of brazing metal through the joint is given a certain amount of impetus by the pressure of the flame, thereby speeding up operations. Satisfactory brazing, however, is in no way dependent upon this so-called "driving effect," but upon the theoretical considerations mentioned earlier.

Furnace Brazing

Both gas and electric furnaces are now being used for aluminium brazing. In this case temperature control is ideal, and beautifully neat and efficient joints can be made in material of almost wafer thickness (metal 0·010 in. thick can be furnace brazed). Unfortunately, furnace brazing results in full annealing of the entire part which is rarely permissible. Nevertheless, it is possible that automatic furnace brazing may find uses in the future in connection with the joining of small heat-treated parts, where some sort of controlled procedure of solution treatment and artificial ageing might be adopted in conjunction with the brazing operation. Since alumina is not reduceable in the ordinary way, hydrogen atmosphere furnaces can offer no advantage over others for the brazing of aluminium. Temperature control should be close, to within $\pm$ 3° C. for careful work, and every effort to ensure uniformity of heating should be made. Time required will vary according to section size and will be that necessary to reach the brazing heat plus 2–8 minutes at the melting temperature to allow the brazing alloy to flow into the joint. Some firms prefer to work on a time basis only and to run the furnace at a relatively high temperature, carrying out a few experimental joints under normal loading conditions. In this way the heating time is kept very short, and will as a result provide maximum brazing efficiency.

Dip Brazing

Dip brazing is carried out to some extent, and in this case the assemblies, with alloy preplaced, are immersed in molten flux baths. Brazing time is extremely short—a matter of seconds with small parts. Jigs are normally used which will introduce the usual problems of differential expansion in the bath, with attendant distortion difficulties, and must be considered accordingly.

Heat Affected Area in Aluminium Brazing

From the practical standpoint, there is no difference in the heat affected area of welded and brazed joints; the effect of heating will, in each and every case, regardless of condition or temper beforehand, leave material with strength no greater than that of the annealed parent plate. Brazed commercial purity aluminium and the low-alloy, low strength materials with "soft" strengths around the 6–7 tons/sq. in. mark will fail under test in the heat-affected zone, since the "cast" strength of the brazing alloy is about 10 tons/sq. in. As a general rule, brazed joints are slightly stronger than fusion welds in the same material, which is probably due to more pronounced grain growth in the latter case, occasioned by a higher working temperature. The operations of both welding and brazing will destroy, permanently, any effect of cold work or heat treatment previously applied. The subsequent working of brazed joints is usually out of the question, but quenching of heat-treated material in lukewarm water immediately after the flux has "set" (i.e., about 500° C.) may be practical with small parts, and a little of the strength may be recovered in due time. The obvious way is to subject such parts to an appropriate heat treatment afterwards.

Some reduction in hardness must accompany any loss of strength, and the actual area concerned will depend largely upon the heating medium used, and the time of brazing; normally it is fairly wide owing to the high rate of heat transfer in aluminium. Gas-air torches give a wide heat affected zone; oxy-coal gas, hydrogen, etc., somewhat less, whilst oxy-acetylene gives the narrowest of all, and for that reason is usually preferred.

Photomicrographs of brazed joints indicate good diffusion between parent and brazing alloy, and their basic similarity provides an intimacy of contact at the interface shown by few other brazing processes. There are no galvanic corrosion effects afterwards.

Treatment of Brazed Joints

The flux used in brazing is extremely corrosive to aluminium, and in all cases the joint must be treated thoroughly afterwards in order to remove the residue. The need for this treatment cannot be overstressed; many a perfect joint has collapsed at short notice as a result of failure to carry it out. The procedure is simple, and very well known, and involves washing repeatedly with scrubbing, in hot, almost boiling water. A steam jet is also very good. Further treatment in 5% nitric acid, followed by more washing is sometimes carried out where joints are not accessible for scrubbing. Washing and scrubbing will usually suffice, however, and it is important that washings should be carried away from the work or they will re-infect the part. Hot, running water is to be preferred, and the removal of all flux residues ought really to be carried out within half an hour or so of the completion of brazing.

Appearance and Finishing

Brazed joints require very little finishing; colour match is perfect for most practical purposes, and the small fillet of brazing metal present is an advantage rather than otherwise. If the job has been properly done, there is no evidence of applied heat on the reverse side of the work; blisters, crinkles, general roughness and "bloom" indicate too high a working temperature. Absence of complete penetration is suggestive of

insufficient heating, or unequal heating of the relative parts.

Limitations of the Process

A difference in constitution of the brazing alloy and the metal being brazed may give rise to some trouble where special process surface treatments are to be applied afterwards. A notable example is anodizing, or anodize dyeing where, due to preferential attack of the brazing alloy during treatment it assumes a darker colour, so providing undesirable contrast and discontinuity of finish. The effect is an unfortunate one, and many ideal applications of brazing in architectural metalwork may not be realised because of it. There is little which can be done, and welding with rods of identical composition is the only real answer to the problem. The objection will not arise where parts are finished by painting, metal spraying, etc. In like manner, the fabrication, by brazing, of tanks and vessels which are to operate in contact with corrosive media may not be considered practical, since differential attack will again take place. The objection is not always serious, but here also, welding with a rod of near composition will be necessary in many cases, and it is not out of place to mention at this juncture that where parts have to withstand corrosion by nitric acid, the aluminium-silicon brazing alloy is comparatively useless.

Applications

The uses of aluminium brazing increase almost daily, and the process has a wide field of application in the radio and allied trades. It may well extend to building, and has become an accepted method of fabricating light alloy window frames ; it has recently been employed in glazing. There could be no more natural application for brazing than in the manufacture of aluminium domestic ware, light alloy kitchen craft, and household furniture. Cabinets, brackets, tubular assemblies and frames for a hundred and one uses are now fabricated by brazing instead of welding because of its simplicity. It is also being used in the aircraft and automobile trades, for partitions and shelves of refrigerators, and for petrol and oil tanks. The potential applications are many, and the use of brazing as a means of joining aluminium to other metals—e.g., steel and cast iron which have been previously aluminium coated, or treated with tin or zinc, may certainly become important in the case of items such as heat exchangers, cylinder fins, and the like.

Education and Training in the Steel Industry

HOWEVER much opinions may vary on the methods employed to train industrial operatives, the need for educational schemes has become increasingly apparent since the last war. Whether these schemes are developed and operated by individual firms, associations, or particular industries they must be effective in supplying the various industries with the right type of recruits to maintain an efficient works personnel. In this connection the British Iron and Steel Federation are doing valuable work with a view to ensuring adequate recruitment for the iron and steel industry. A Report,* recently published by this Federation, covers the second of the industry's training conferences, both of which have been held at Ashborne Hill, Leamington.

At this second conference 130 delegates, representing about 50 companies, met in a plenary session for the five sessions of the conference—three of the sessions being followed by group discussions. The complex and difficult problems of training junior operatives and clerks, subjects which had received considerable attention at the first conference, were discussed in greater detail. On the training of junior operatives Mr. F. B. Canning Cooke outlined a training scheme which had been introduced in a heavy steel works with coal washeries, coke ovens, blast furnaces, open-hearth shops, heavy plate and heavy bar mills, the complete plan being presented in this report, together with the discussion which followed and a final summing up.

Consideration of a new phase was the extension of the training idea to include not only juniors, but adults, and the problem of training foremen was included. The subject was treated in the form of a dramatised Works Committee meeting introduced by Mr. D. R. O. Thomas, the action taking place in the Works Manager's office. Discussion groups were formed to consider this question of the training of foremen along the lines broadly developed in the dramatised meeting. A duologue on training the clerk between Mr. G. F. Satow and Mr. G. H. T. MacLeod is also reported, as is an address to members of the conference on how the Government can help, which was given by Mr. F. Bray, of the Ministry of Education.

In his concluding remarks, the chairman of the conference, Mr. Gerald Steel, emphasised the necessity of convincing all levels of management of the sincerity of ideas on training ; these new ideas, he said, whether on welfare, education or consultation, will never be accepted unless every foreman in the works, the managers and, most important of all, the highest management, are 100% sincere.

It is noteworthy that a further education and training conference is to be held at the end of October this year when Mr. Gerald Steel will again be in the chair. Meanwhile those interested in solutions to this difficult problem of recruitment and education for industry will find the ideas discussed in this report not only interesting but informative and invaluable in arriving at a proper appreciation of the difficulties encountered.

* Published by the British Iron and Steel Federation, Steel House, Tothill Street, London, S.W. 1, price 2/6d.

Extruded Sections in Aluminium and Aluminium Alloys

A NEW publication on the above subject, recently published, provides a very useful introduction to the manufacture of extruded sections which gives a clear picture of their potentialities. A survey is first given of the characteristics of aluminium and its alloys, including tables of the properties of those materials in which extruded sections are produced. The extrusion process is then described in principle to clarify the subsequent account of certain factors in design which are of importance in ensuring the highest efficiency in production. Illustrations show those problems which can be profitably discussed between user and producer at the design stage and the special features and advantages of the process.

Information Bulletin No. 16, published by The Aluminium Development Association, 33, Grosvenor Street, London, W.1, price 1s.

The Corrosion of the Austenitic Stainless Steels

Part IV—Effect of Alloying Elements and of Corrosive Media

By G. T. Colegate, B.Sc., A.I.M.

Considerable progress has been made, during the last thirty years, in the development and application of the austenitic stainless steels. In a series of four articles, the author discusses many factors governing the corrosion of these steels, including the effect of alloying elements in addition to chromium and nickel, and of the corrosive media with which the material may come into contact in service.

TO conclude this series of articles on the corrosion of austenitic stainless steels, their behaviour when subjected to attack by various liquids and gases will now be discussed. The groups of substances to be considered include acids, alkalis, salts, food products, natural waters, non-aqueous liquids and gases.

Resistance to Acids

The behaviour of the austenitic stainless steels in acids depends largely on the nature of the acid. Those acids, such as nitric, which have high oxidising power, usually attack the steels to a negligible extent. On the other hand, acids such as hydrochloric, which have virtually no oxidising power, attack the stainless steels quite rapidly. In many cases, however, whether or not an acid attacks stainless steel will depend largely on its dissolved oxygen content. It is quite possible for the dissolved oxygen virtually to prevent attack, whereas the same medium, in the absence of oxygen, would cause appreciable attack on the steel. To some extent, the effect of dissolved oxygen depends on the concentration of the medium, and is naturally more pronounced in the weaker concentrations.

Other oxidising agents than oxygen itself (for example, ferric salts) are effective in producing passivity in acid solution. In general, these materials are rather more effective than oxygen in this respect.

Nitric Acid.—A vast amount of stainless steel is used in the manufacture, transport and storage of nitric acid. Provided the chromium content of the steel is sufficiently high, almost any concentration of acid may be used in contact with the steel, but the rate of attack varies quite considerably with the concentration and temperature. The rates for several steels, under a number of conditions of temperature and acid concentration, are shown in Table I. It must be borne in mind that much of this information is based on laboratory tests, using chemically pure acid and if, in practice, impurities are present in the acid, the rates of attack may be appreciably increased; chlorides are particularly liable to accelerate the attack of nitric acid on the stainless steels. The figures given in the table represent average values, based on loss in weight determinations. No account is taken of any tendency to pitting, a mode of attack which is not frequently met with under the conditions in question, however.

Figures obtained by different investigators, for the rate of attack by nitric acid on these steels, vary considerably among themselves, and to some extent the differences are probably due to the heat treatment

TABLE I.—ACTION OF NITRIC ACID ON AUSTENITIC STAINLESS STEELS

Alloy	Acid Concentration	Corrosion. Inches per Year		
		70° F.	110° F.	Boiling
Cr 17–19%, Ni 8–10%, Mn 2% (max.)	5–50%	<0·0042		0·0042
	65%	<0·0042		0·004–0·04
	Conc.	<0·0042		0·04–0·12
	Fuming Conc.	<0·004	<0·004	0·12–0·42
Cr 16–18%, Ni 10–14%, Mn 2% (max.), Mo 1·75–2·5%.	5–50%	<0·004		0·0042
	65%	<0·0042		0·004–0·04
	Conc.	<0·0042		0·04–0·12
	Fuming Conc.	<0·004	<0·004	0·12–0·42
Cr 17–19%, Ni 8–11%, Mn 2% (max.), Ti 4 × C.	Conc.	<0·004		
Cr 24–26%, Ni 19–22%, Mn 2% (max.)	5% Conc.	<0·004	0·0084	

which the metal received prior to testing, since heat treatment may appreciably affect corrosion resistance. It will be seen from Table I that the rate of attack is, in general, greater in the boiling acid than in acid at room temperature.

Sands[1] describes work on the corrosion resistance of various stainless steels from the point of view of storage and transport of nitric acid. He concludes that all the grades of stainless steel tested are suitable for use with 93% and 95% acid. The steels included the following compositions:—Cr 19·40%, Ni 9·26%; Cr 18·86%, Ni 11·45%; Cr 25·48%, Ni 14·34%; Cr 24·77%, Ni 18·30%. The second of the four also contained 0·86% of columbium. The work in question included examination of welded specimens and emphasised the necessity for carrying out the correct heat treatment on the unmodified steels, in order to ensure freedom from intercrystalline attack; the columbium-bearing steel required no such heat treatment, of course. The first two grades of steel are also recommended for use in the transport and storage of 97% and 99% acid though, under conditions of storage which are relatively severe, their utility will depend largely on the quality of acid required, since the rates of attack are sufficient to give noticeable contamination. It is pointed out in the article, however, that stainless steel drums of the compositions in question have been successfully used for nitric acid transport without undue contamination of the acid, which appears to indicate that the conditions used in the examination described were rather more severe than those encountered in practical operations.

Kaplan and Andrus[2] studied the corrosion of various stainless steels, including certain austenitic ones, in red

1 *Ind. Eng. Chem.*, 1948, **40** (10), p. 1937.
2 *Ibid*, p. 1946.

fuming nitric acid and in a mixture of nitric acid (95% +) and fuming sulphuric acid containing 20% by weight of sulphur trioxide. The rate of attack at room temperature, with nitric acids containing 6·5% and 16%, respectively, of nitrogen peroxide was of the order of 2–4 mg./sq. dm./day. At temperatures between 250°–300° F. the corrosion rate is greater and is of the order of 10,000 mg./sq. dm./day; this would rule out these alloys for use with fuming nitric acids at such temperatures. With the nitric-sulphuric acid mixture the rates of attack at room temperature are slightly greater than with the fuming acids, and are of the order of 3–5 mg./sq. dm./day but, on the other hand, increase in temperature does not result in nearly the same degree of acceleration of attack as occurs with the latter acids. At 250°–300° F. rates of attack on the austenitic steels are of the order of 400 mg./sq. dm./day maximum. An 18 : 8 steel containing small additions of molybdenum had a corrosion rate, under these conditions, of only a tenth of the above figure, while a columbium-modified 18 : 8 steel showed a corrosion rate intermediate between the two. The 400 mg./sq. dm./day rate of attack was obtained on a straight 18 : 8 steel and a titanium-modified 18 : 8.

Sulphuric Acid.—Whereas, in the case of nitric acid, the austenitic stainless steels are resistant under most conditions of exposure, the position is rather different with sulphuric acid since, under some conditions, the stainless steel is rendered passive by contact with the acid, and under others it remains active and corrosion proceeds rapidly. Temperature, concentration and the presence or absence of oxidising agents all influence the corrosivity of sulphuric acid towards stainless steels. Air present in the acid is often sufficient to confer passivity on the steel. Other oxidising agents which also produce passivity include nitric acid, copper sulphate, ferric sulphate, silver sulphate and mercurous sulphate. With regard to the effect of temperature on passivity, in the case of exposure to sulphuric acid containing no oxidising agent except dissolved air, increase in temperature, not surprisingly, causes an increase in the rate of attack, since the solubility of air is lower at the higher temperatures. As far as concentration is concerned, the strong acid at room temperature is more oxidising and therefore less corrosive than the more dilute acid. However, at elevated temperatures, even the strong acid causes rapid corrosion of the austenitic stainless steels.

It is not surprising that there are many contradictory results reported in the literature on the corrosivity of sulphuric acid solutions on stainless steels. In some cases complete passivity is reported under a given set of conditions, and yet other workers report attack under what are apparently exactly similar conditions. There is no doubt that the exact condition of heat treatment has some influence in deciding whether or not a stainless steel will prove to be active or passive under given conditions of exposure.

Quite apart from the effect of heat treatment in influencing the possibility of intercrystalline corrosion, general corrosion resistance is also affected. Correct heat treatment assures the widest possible range of passivity in corrosive solutions. Thus, heating to 1,050°–1,100° C. and cooling rapidly produces in these steels a homogeneous austenitic structure which has the maximum resistance to attack. Slow cooling, even if it does not result in intercrystalline attack, will often reduce the overall resistance to corrosion.

The importance of the presence or absence of oxygen in the acid is illustrated by some figures given by McKay and Worthington,[3] who state that in a 1% and a 3% solution of sulphuric acid saturated with oxygen the rates of corrosion were, respectively, 2 and 4 mg./sq. dm./day whereas, if hydrogen were passed through the solution, the rate with the 1% acid was 96 mg./sq. dm./day and that for the 3% acid was as high as 440 mg./sq. dm./day.

Table II gives some typical figures for the corrosion of a number of stainless steels of the austenitic type when in contact with various concentrations of sulphuric acid. In all cases the rates of attack in boiling acid are of the order of 2,000 mg./sq. dm./day.

TABLE II.—ACTION OF SULPHURIC ACID ON AUSTENITIC STAINLESS STEELS

Alloy	Acid Concentration	Corrosion. Inches per Year	
		70° F.	Boiling
Cr 17–19%, Ni 8–10%, Mn 2% (max.)	5%	0·04–0·12	>0·42
	10%	0·04–0·12	>0·42
	50%	0·12–0·42	>0·42
	Conc.	<0·004	0·12–0·42
	Fuming	0·04–0·12	
Cr 16–18%, Ni 10–14%, Mn 2% (max.), Mo 1·75–2·5%	5%	0·004–0·04	0·04–0·12
	10%	0·004–0·04	0·12–0·42
	50%	0·04–0·12	0·12–0·42
	Conc.	<0·004	0·12–0·42
	Fuming	0·004–0·04	
Cr 18–20%, Ni 8–10%, Mn 2% (max.)	3%	0·049	
	3–40%	>0·10	
	Conc.	<0·004	

There is a considerable amount of data available in the literature on the rates of attack produced by various concentrations of acid containing oxidising agents of different kinds. In general, at the higher temperatures, the effect of the oxidant falls off very considerably and very high rates of attack are reported.

The composition of the steel affects its behaviour in the presence of sulphuric acid. Molybdenum additions greatly improve the corrosion resistance, provided that about 2% of this element is present. Corrosion rates at room temperatures in non-aerated 10% acid are negligible with an alloy of this type, while at moderately elevated temperatures rates of attack are only a tenth to a hundredth of those on non-molybdenum steels under the same conditions.

Hydrochloric Acid.—Except for very low acid concentrations, and then only at low temperatures, the austenitic stainless steels are unsuitable for use in contact with hydrochloric acid. There is some evidence that passivity develops under some conditions, but only in weak acids. On the other hand, addition of molybdenum has a marked effect on the resistance of these steels to hydrochloric acid, and even in boiling acid, in concentrations up to about 3%, an addition of 2% molybdenum reduces the attack to negligible proportions. At room temperature, molybdenum additions are effective in concentrations of hydrochloric acid up to about 15%. Beyond that concentration, the attack increases quite rapidly. These remarks refer to steels of comparatively high chromium content—of the order of 25%.

Hydrofluoric Acid.—The austenitic stainless steels are not normally used in contact with hydrofluoric acid, the rate of attack being such as to rule them out for practical purposes.

3 "Corrosion Resistance of Metals and Alloys" (Reinhold), 1936.

Sulphurous Acid.—Austenitic stainless steels are very resistant to sulphurous acid, under most conditions of exposure, and for this reason are widely used in the paper industry for handling sulphurous acid solutions of various strengths and degrees of purity. It is of interest to note that the nickel present in this type of steel has an important influence on the resistance to corrosion for, although the straight chromium-iron alloys will effectively resist attack by sulphurous acid provided the chromium content of the alloy is sufficiently high, the presence of appreciable quantities of nickel lowers the limiting amount of chromium that is required to ensure absence of corrosion. Molybdenum also, as in the case of corrosion by hydrochloric acid, has a beneficial effect on the corrosion resistance in the presence of sulphurous acid, and is particularly desirable in those alloys which are intended for use with hot, strong solutions of sulphurous acid. As an example of the effect of molybdenum on the behaviour of these steels may be quoted the fact that corrosion rates on straight 18 : 8 chromium-nickel steel, in sulphurous acid at temperatures above about 300° F. and under pressure, may be of the order of 600–700 mg./sq. dm./day, whereas at this temperature and up to about 350° F. the rate of corrosion on a molybdenum bearing 18 : 8 steel is of the order of 15–20 mg./sq. dm./day.

Even in the relatively impure solutions of sulphurous acid encountered in practice, the 18 : 8 steels give excellent performances but the presence of certain impurities such as chloride may greatly increase the rate of corrosion. It is said that, if sulphurous acid is allowed to oxidise to an appreciable extent, producing sulphuric acid, the rate of attack on stainless steels is considerably increased.

TABLE III.—ACTION OF PHOSPHORIC ACID ON AUSTENITIC STAINLESS STEELS AT 70° F.

Alloy	Acid Concentration	Corrosion. Inches per Year
Cr 17–19%, Ni 8–10%, Mn 2% (max.)	1–5% 10% quiet 10% agitated 10% aerated	<0·0042 0·004–0·04 0·04–0·12 0·04–0·12
Cr 18–20%, Ni 8–10%, Mn 2% (max.)	1% 10% agitated	<0·0042 <0·12
Cr 16–18%, Ni 10–14%, Mn 2% (max.), Mo 1·75–2·5%	1%, 10% 25%, 50% 85%	<0·0042 <0·0042 <0·0042

Phosphoric Acid.—Although there is a great deal of conflicting evidence on the behaviour of austenitic stainless steels in contact with phosphoric acid, appreciable quantities of the material are used in contact with it. Concentration and temperature of the acid naturally influence its behaviour. The figures in Table III indicate the order of attack which takes place on various steels at room temperature. At boiling point the attack is, in general, much greater and is sufficient to rule out the austenitic stainless steels in this application. Additions of molybdenum do not appear to have the beneficial influence that they do in the case of sulphurous acid. Crude phosphoric acid containing appreciable quantities of hydrofluoric acid should not be used in contact with the austenitic stainless steels.

Acetic Acid.—At room temperature the austenitic stainless steels are suitable for handling acetic acid in any concentration. The figures in Table IV show typical rates of attack by various concentrations of acetic acid at room temperature. In hot acid, it is difficult to predict the likely behaviour of these steels, but the corrosion rate is often not more than 10 mg./sq. dm./day. Glacial acetic acid and acetic anhydride behave in much the same way as acetic acid itself.

TABLE IV.—ACTION OF ACETIC ACID ON AUSTENITIC STAINLESS STEELS AT 70° F.

Alloy	Acid Concentration	Corrosion. Inches per Year
Cr 17–19%, Ni 8–10%, Mn 2% (max.)	10–80% 100%	<0·0042 <0·0042
Cr 18–20%, Ni 8–10%, Mn 2% (max.)	3% 20% 40%	0·0047 0·0043 0·0216
Cr 16–18%, Ni 10–14%, Mn 2% (max.), Mo 1.75–2.5%	All Concs.	<0·0042

Molybdenum additions have been shown to have a beneficial effect in both aqueous and glacial acids ; a similar effect is observed with acetic anhydride. Several alloys in this range have been examined with additions of molybdenum and in all cases the presence of this element has been shown to be beneficial.

Organic Acids.—Most of the commonly encountered organic acids may be handled in austenitic stainless steels at room temperature without serious corrosion. Table V shows some typical rates of attack. At higher temperatures the rate of attack varies considerably and an indication of what may be expected is given by the typical figures quoted in the table mentioned.

TABLE V.—ACTION OF ORGANIC ACIDS ON AUSTENITIC STAINLESS STEELS

Alloy	Acid	Concentration	Corrosion. Inches per Year	
			70° F.	Boiling
Cr 17–19%, Ni 8–10%, Mn 2·0% (max.)	Chloracetic	Conc.	>0·12	
	Citric	5% Quiet 10–50% 10%, 15% 25%, 50% Conc.	<0·0042 <0·0042	 0·0042–0·042 0·12–0·42 0·042–0·12
	Fatty Acids	Conc.	<0·004	
	Formic Acid	5% 10% 50% 90% 100%	<0·0042 <0·0042 <0·0042 <0·0042 <0·0042	0·004–0·04 0·004–0·04 0·004–0·04 0·004–0·04
	Lactic Acid	1% 5% 10% Conc.	<0·004 <0·004 <0·004 <0·004	<0·004 0·004–0·04 0·12–0·42 0·042–0·12
	Oxalic Acid	5% 10% 50% Conc. Sol.	<0·0042 <0·0042 <0·0044	<0·0042 0·12–0·42 0·12–0·42 >0·44

Resistance to Salt Solutions

With the exception of solutions containing chloride, most salt solutions do not attack stainless steels of the austenitic type as they usually contain sufficient oxygen dissolved in them to maintain the oxide film on the surface of the metal. Sulphates, phosphates, chromates, nitrates, etc., all give negligible corrosion rates ; bleaching powder and hypochlorites attack stainless steels.

Chloride solutions, on the other hand, may cause very rapid attack, particularly at elevated temperatures. Especially severe in its action on stainless steel is copper chloride, with ferric chloride almost as bad ; stannic chloride and mercuric chloride are likewise corrosive towards these materials. The chlorides mentioned cause definite and general attack on stainless steel, but frequently chloride solutions, such for example, as sea water, cause pitting rather than general attack. This

phenomenon and its causes are discussed elsewhere. On the other hand concentrated solutions of chloride, such as sodium or calcium brine can be used at room temperature in contact with stainless steel without the latter being corroded, either by general attack or by pitting. The same applies to dilute solutions of pure chlorides, but such factors as contact in the presence of chloride or, in the case of sea water exposure, marine growth, are important in determining whether pitting will take place or not.

Resistance to Alkalis

The caustic alkalis, at room temperature, have no appreciable effect on 18 : 8 stainless steel, the loss in weight being in many cases immeasurable. On the other hand, as the temperature increases, particularly with increase in the concentration of the alkali, attack becomes more rapid, though it is seldom very great, even at boiling point, with concentrations less than about 50%. In the respect that attack increases with concentration and temperature, the stainless steels differ from straight carbon steels which show considerably less attack than stainless steel at boiling point. Fused alkalis attack stainless steels quite severely.

Ammonia is virtually without effect on stainless steels and so are solutions of calcium and magnesium hydroxides.

Resistance to Food Products

In general, 18 : 8 stainless steel is the ideal material for handling and processing food products. It has proved entirely satisfactory over a wide range of products and conditions of temperature and has been used for handling beer, milk, coffee, fruit juices, sugar products, vegetable oils, etc. The amount of corrosion is frequently too low to measure and is seldom more than 1 mg./sq. dm./day. Pitting has occasionally been reported in conditions where there is a high chloride concentration but, otherwise, the most that is noticed is occasional staining, and even this is rare.

Resistance to Natural Waters

It is only in sea water that there is appreciable risk of corrosion of stainless steel. In ordinary domestic waters, river water, etc., such attack as may take place is very superficial and is confined to light surface rusting. Pitting can occur in such waters, usually as a result of contact with some non-metallic material, but it seldom, if ever, develops to an extent that can be regarded as serious.

The behaviour of stainless steels in sea water is mentioned elsewhere in connection with pitting. They do not as a rule suffer general corrosion when so exposed, but almost invariably, if attack occurs, it is in the form of pits. These usually start at crevices, surface defects or, more often, under marine growths which have become attached to the surface. It is by no means certain that pitting will occur when stainless steel is immersed in sea water but in most cases it does, though the time required for it to make itself evident will vary very considerably with the conditions of exposure. The effect of movement of sea water is mentioned elsewhere, rapidly moving water having less tendency to cause pitting than stagnant water. The intensity of pitting will also depend very largely on the local type and abundance of marine growth, the more prolific the fouling the greater the risk of attack ; water temperature also has an effect.

Tests carried out by the International Nickel Co. have shown that, under the least favourable conditions of exposure, namely, in stagnant or nearly stagnant warm sea water either with complete or partial immersion, the austenitic stainless steels give better performances than the straight chromium iron alloys, both from the point of view of total amount of metal lost and the maximum depth of pitting. In the case of a 13% chromium-iron alloy the weight lost from a specimen 1 ft. square was 0·30 gr. per day. With a 17% chromium-iron the loss was reduced to about half that amount, whereas the austenitic stainless steels had a loss in weight of the order of 0·01–0·03 gr./day. Furthermore, whereas the maximum depth of pitting on the straight chromium-iron alloys was of the order of 0·07 in. per year, that on an alloy containing 25% chromium and 20% nickel was only 0·007 in. per year. However, the maximum pitting depth with an 18 : 8 stainless steel was the same as that of the straight chromium-iron. The most interesting point brought out in this work is the remarkable effect of molybdenum additions to 18 : 8 stainless steel. In the presence of this element both weight loss and maximum pitting depth were appreciably reduced, the former to 0·007 gr./day from a specimen 1 ft. square and the latter to 0·007 in./year.

Although the results just described were obtained under adverse conditions of exposure, the general conclusions apply under less severe conditions, namely, that the austenitic stainless steels give the best all-round service in sea water of any of the stainless steels, and that the presence of molybdenum is an advantage.

There is an appreciable amount of evidence in support of the conclusion that the presence of molybdenum in 18 : 8 stainless steels improves their resistance to sea-water attack. Not only is the maximum depth of pitting reduced considerably by such additions, but so is the incidence of pitting. The writer has seen many sets of specimens in which there has been random, and sometimes deep, pitting on perhaps a dozen large samples of straight 18 : 8 alloy, whereas on the same number of molybdenum-bearing 18 : 8 samples about two-thirds were completely immune from attack of any kind and there was perhaps a single pit on each of the others.

If conditions are particularly favourable to pitting, the rate of penetration in sea water may be quite rapid. The writer has known of instances where pitting has proceeded at a rate of nearly an inch per year, and although this rate of attack is unusually rapid, it is by no means unique.

When exposed to sea water, the effect of surface condition may be in the reverse direction to that normally observed, that is to say the rougher the surface, the less the risk of attack. This point is made by La Que[4] who states that under stagnant conditions resistance to attack is not improved by providing the steel with a very smooth surface. A relatively rough surface gives many more points at which attack is likely to start, but the attack being more widespread is likely to be shallower than would be the case if there were a few isolated pits as might occur on a smooth surface. It is furthermore pointed out that protective calcareous deposits adhere more firmly to a roughened surface.

Corrosion by Non-aqueous Materials

The austenitic stainless steels are, in general, very resistant to non-aqueous liquids but some, such as

4 "Corrosion Handbook" (Wiley), 1948, p. 383.

TABLE VI.—ACTION OF NON-AQUEOUS MATERIALS ON AUSTENITIC STAINLESS STEELS

Medium	Temp. °F.	Penetration in Inches per Year		
		18 : 8	18 : 8 + Mo	18 : 8 + Ti
Acetone	70	⩽0·003	⩽0·003	⩽0·003
	Boiling		⩽0·0042	
Aniline (Crude)	—	⩽0·004	⩽0·004	⩽0·004
Benzol	70	⩽0·004	⩽0·004	⩽0·004
Bromine	70	Rapid Attack	Rapid Attack	Rapid Attack
Ethyl Alcohol	70	0·003	0·003	0·003
Ethyl Chloride	70	Negligible	Negligible	Negligible
Glycerine	70	,,	,,	,,
Linseed Oil	70	,,	,,	,,
Ethylene Chloride	70	,,	,,	,,

bromine and iodine, produce rapid corrosion. Some typical results are given in Table VI.

Corrosion by Gases

Typical figures for the corrosion of austenitic stainless steel by various gases are given in Table VII.[5] It is clear that fairly serious attack takes place with several of the gases mentioned in the table if they are moist,

TABLE VII.—ACTION OF GASES ON AUSTENITIC STAINLESS STEELS

Medium	Temp. °F.	Penetration. Inches per Year		
		18 : 8	18 : 8 + Mo	18 : 8 + Ti
Chlorine (Wet)	70	0·12-0·42	0·4-0·12	0·12-0·42
Sulphur Dioxide (Wet)	70	⩽0·004	⩽0·004	⩽0·004
Sulphur Dioxide (Dry)	575	⩽0·004	⩽0·004	⩽0·004
Ammonia (Dry)	70	⩽0·004	⩽0·004	⩽0·004
Hydrogen Chloride (Dry)	70	Attacked	Attacked	Attacked
Hydrogen Chloride (Wet)	70	Badly Attacked	Badly Attacked	Badly Attacked
Hydrogen Fluoride (Dry)	70	Attacked	Attacked	Attacked

much less attack taking place if they are dry. In the case of hydrochloric acid, fairly heavy attack occurs in the dry state and very heavy attack in the moist condition.

As pointed out earlier, high-temperature conditions are considered outside the scope of this article and no reference will therefore be made to attack by hot gases.

5 *Ibid*, p. 157.

Development in Non-Ferrous Metal Production at Vickers-Armstrong's

Reconstruction and Modification at Elswick Works

A reconstruction scheme recently completed in the non-ferrous section of the cast and wrought metals department at the Elswick Works of Messrs. Vickers-Armstrong, Ltd. has involved the demolition of many old buildings erected in 1847 *when the Works started—and marks a further advance in the history of the manufacture of cast and wrought non-ferrous products extending over* 50 *years. Brief particulars are given of the modifications incorporated in the new scheme.*

CASTING, rolling and extrusion of non-ferrous metals have been carried on at the Elswick Works of Vickers-Armstrong for a great number of years, and the recent completion of a comprehensive scheme of reconstruction and modernisation, which has involved the installation of much new plant in modern buildings, will greatly increase the facilities for the manufacture of high-grade products at these works. The area now occupied by the non-ferrous section is approximately 6¼ acres, of which 5 acres is taken up with buildings, the main group housing the principal plant installations. Transport facilities by road and rail are provided.

Much attention has been devoted to the layout of the whole department, and by placing the metal stores in a fairly central position it has been possible to achieve a considerable degree of straight-line production for both cast and wrought products. To the west of the stores lies the brass foundry, while to the east of the stores is the electric melting shop, leading to the billet and slab stores, which in turn leads to the extrusion shop and rolling mill. The despatch bay of these two shops is at the extreme east end and is transverse to the main bays. All incoming metals are delivered by road or rail into the metal stores, where metallurgical control starts, and from which samples are taken for chemical analysis.

Brass Foundry

The brass foundry is divided into four bays, three of which are devoted to green and dry sand moulding and coremaking and the fourth to the dressing and finishing of castings. Moulding sand, which is delivered by rail to bunkers on the north of the foundry, is prepared under controlled conditions in a modern sand-handling plant. A battery of centrally placed tilting furnaces, with efficient fume extraction, supplies the molten metal, and castings up to 2 tons finished weight in manganese bronze, phosphor bronze or gunmetal, and up to 10 cwt. in aluminium alloy can be made. Moulds and cores are dried in Mathison gas-fired stoves. A Birlec rocking arc furnace of ¼ ton capacity is used for the manufacture of "hardener" alloys and for the melting of copper, P.M.G. silicon bronze, etc. A section of the foundry is devoted to the manufacture of chill-cast solid and centrifugally spun-cast hollow bars in gunmetals and phosphor bronzes.

Electric Melting Shop

The electric melting shop houses twelve Ajax-Wyatt low-frequency induction furnaces—three of 150 K.V.A. capacity and nine of 75 K.V.A. capacity. The furnaces are mounted along the sides of two platforms, which project into the stores, and on which the prepared charges are placed in skips: one platform being mainly concerned with the manufacture of extrusion billets, and the other with rolling mill ingots and slabs. All furnaces are equipped with copper-faced water-cooled moulds of the appropriate size and shape, but all moulds are interchangeable. Every heat is analysed, and every billet and slab carries an identification mark of furnace and cast number. When cool, the extruding billets are

West end of extruding shop with two extrusion presses of 1,500 and 1,000 tons capacity.

Rolling mill from west end showing the Davy-United reversing hot mill.

sawn to the required lengths on high-speed saws, the tables of which are at floor level, between the melting shop and the billet stores, so that billets can be rolled to weighing machines and thence to stock, awaiting analysis. The rolling slabs are allowed to cool and then taken to the slab store where heads are removed on a high-speed circular saw. The slab and billet stores are so arranged that they feed the rolling mills and extrusion shop and form the starting points for the straight line scheme of production for rolled and extruded products, respectively.

Extrusion Shop

Billets to be extruded are weighed and then rolled by gravity down chutes to the billet-heating furnaces adjacent to each press where they are raised by hoist to charging door level. The furnaces have hearths inclined from the charging to the discharging end, and the billets roll through the furnaces ensuring uniform heating. The length of the furnaces has been made such that with the extruding presses working at maximum capacity the heating time ensures soaking with uniform temperature throughout the billets. The furnaces are gas fired with ample control to regulate the heat input for the varying billet sizes.

There are two extrusion presses, and it is noteworthy that both were built in the Elswick Works, one of 1,000 tons capacity, which uses billets of 8, 6 and 5 in. diameter, and one of 1,500 tons capacity, which uses billets of $9\frac{1}{2}$, 8 and 6 in. diameter. The latter press can produce solid bars of 6 in. diameter or hollow bars 6 in. outside diameter by $4\frac{3}{4}$ in. inside diameter. Both presses are equipped with independently-controlled mandrel rams, for the piercing of billets and the production of hollow rods. Water is supplied at a pressure of 3,000 lb./sq. in. from a pneumatic-hydraulic accumulator consisting of five air bottles and one water bottle each of 62 cu. ft. capacity. Two sets of three-throw pumps provide the power, and the operation of the pumps is controlled by a mercury pot, with dip rods, which is alongside the water bottle. Prefilling of the main cylinder and idle strokes are by water at 100 lb. pressure, from air vessels at the rear of each press. A well-equipped tool room is provided for the manufacture of dies and mandrels and the maintenance of press tools. Run-out tables and inclined cooling platforms are 60 ft. long. A portable coiler can be set up as required at either press for coiling long lengths, when single hole dies of $\frac{5}{8}$ in. and less are in use. Such coils are processed on either of two machines designed for drawing, straightening, cutting to length and polishing.

Extruded solid and hollow rounds and hexagons in free machining brasses are usually passed to drawbenches for a sizing draw, through tungsten carbide dies. A modern high-speed push-pointing drawbench has been installed, capable of push pointing up to 3 in. diameter. For larger diameters it is necessary to swage tags for drawing. There are also two drawbenches for sections and light work. Round bars are then passed to a reeling machine of suitable size and conventional design. Hexagon, squares and rectangles go to the multi-roll straightening machines after stress relieving in electric furnaces. Special sections are straightened on hydraulic stretching machines, whilst for some special sections hand straightening is the only possible method.

An important part of the output is stamping bar, and this calls for different handling. Special dies are in use to maintain size limits without subsequent drawing or reeling, as these operations produce unfavourable grain size on re-heating for stamping. Straightening is carried out satisfactorily on the suitable size of multi-roll straightening machines. The smallest rod produced is $\frac{1}{8}$ in. diameter and this is finished on bull blocks, and a special straightening and cut-off machine for these small sizes has been provided.

The finished products pass forward to the saws for cutting to length and final inspection. Inspection, material and dimensional is maintained throughout the sequence of operations, the final inspection being particularly rigorous, with the result that rejections on material despatched from the shop are maintained at an extremely low figure.

Rolling Mill

The rolling mill constitutes the south bay of the main building and is 600 ft. long by 61 ft. 6 in. wide; it is separated from the north bay by a central bay 30 ft. wide, which is occupied by offices, cloak room, tool room pickling tanks, inspection bay and by some of the rolling mill drives.

All material processed in this shop passes first through the Davy & United Engineering two-high reversing hot mill, with rolls of 30 in. dia. by 62 in. face. The slabs are heated in a Mathison gas-fired furnace, charged

in two rows on cast-iron slippers on guide rails. There are twin hydraulic pushers discharging the slabs down inclined roller paths on to rising tables, which are lowered between the live rolls of the roller table. The movements of the doors, pushers and rising tables are interlocked to ensure correct sequence of operation.

The speed and direction of rotation of the work rolls, roller tables and screw-down motors are controlled at a desk by one man. The power unit of this mill is of the most modern design, giving a wide range of rolling speeds and very rapid reversal. The standard slab is 3¼ in. thick and weighs 850 lb., but larger units up to 1 ton can be cast and rolled. Blanks are finished here to ¼ in. thick for sheet rolling or to ⅛ in. for coiling for subsequent strip rolling.

A two-stand two-high mill, having rolls of 20 in. diameter by 60 in. face deals with the requirements of hot-finished sheets. The bulk of the output passes, after annealing and pickling, to a Robertson four-high mill 15 in. and 37 in. by 62 in., equipped with a combined up-coiler and tension-strip reel.

For the rolling of narrower widths of strip the material after annealing and pickling goes to a Davy & United four-high mill 7½ in. and 18 in. by 18 in. with strip-tension reel and belt wrapper. Both these four-high mills are powered through V.S.G. units built at Elswick Works. The V.S.G. units ensure flexible control with constant tension on the strip during the build-up on the reel, over the whole range of speeds. The smaller mill also has V.S.G. control for the screw down, giving very rapid and sensitive adjustment, and is the first rolling mill in the world to be equipped throughout with V.S.G. power units.

For the finish temper rolling of sheets up to 1 metre wide a two-stand two-high mill is used, whilst a two-high mill serves the same purpose for strip. For the annealing of sheets and strip in coils, two Mathison gas-fired furnaces, served by an electric-charging machine, are installed, and a Curran combined annealing and pickling unit handles sheet and strip.

The finishing section is well equipped with slitting and shearing machines, and a number of roller levellers. The largest of the latter is capable of levelling plates up to 1 in. thick, and has been installed to level condenser plates and to work in conjunction with a Robertson scalping machine, for special requirements. The grinding of the rolls is carried out on a Craven roll-grinding machine, fitted with a cambering device and capable of handling the largest rolls in use in the mill.

Finished sheet and coil is finally inspected before passing to the warehouse and despatch bay, which covers the full width of the main bays and centre bay, as well as a rail dock annexe.

Ancillary Buildings

The main road, with railway, separates the large block from the ancillary buildings on the north. These consist of stores, metal recovery, ablutions, ambulance room, sub-station, pump house and millwrights shop.

In the metal recovery plant an important operation is carried out. Here are treated the drosses and skimmings from the electric melting furnaces and the ashes from the foundry. On a battery of inclined ball pans, with independent motor drive rotating each pan, with a controlled water spray, the drosses are ground and washed away leaving the metal residues to be dried, magnetted and remelted for use. A very high percentage of the metal content is recovered.

The ablution building is an innovation. In addition to the usual washing facilities, shower baths have been provided, as well as about 150 pressed steel lockers. Before starting work the men may change into their work clothes, leaving their better clothes locked up, and at the end of the shift they can have a hot shower and change again. The ambulance room, of great importance, is well equipped and skilled attendance is available, both night and day.

The pump room houses the two sets of hydraulic pumps which supply the needs of the presses, as well as compressors for the compressed air service throughout the department, and a set for the maintenance of the air pressure in the accumulator air bottles.

The ventilation, heating, lighting and decoration of the various shops are of a uniformly high standard and provide ideal working conditions and the Company is to be congratulated on the efforts made to reconstruct, equip and generally to reorganise the non-ferrous section of the Elswick Works which will undoubtedly bring about increased production and a further advance in the quality of the products in which this Company specialises.

Ductile Cast Iron

THE discovery that small percentage of magnesium added to suitable compositions confers remarkable properties on cast iron has considerably widened the scope of this material. Probably the most important of the properties of the cast iron so treated is that of ductility, although tensile strength is greatly increased. The successful development of the magnesium process is the result of research carried out in the laboratories of the International Nickel Co. and the Development and Research Department of the Mond Nickel Co., Ltd.

A licence to manufacture by this process on a commercial scale has been taken out in connection with which a twenty-minute film was recently shown in London. The film was produced for Messrs. Lloyds (Burton), Ltd., under the technical supervision of Mr. A. B. Lloyd, B.A., sales director of Messrs. F. H. Lloyd & Co., Ltd., Wednesbury, and its associated companies. The film tells the story of the development of this spheroidal graphite cast iron and depicts commercial production of castings at a Burton-on-Trent foundry. For greater convenience the material has been given the name Lloyd's Ductile Cast Iron.

Among the properties of magnesium treated iron, it is noteworthy that its fatigue ratio is consistently about 45% of the tensile strength, whether in the as-cast or heat-treated condition. Test pieces record a tensile strength of 36 tons/sq. in. and an elongation of 16·5% in 2 in. On impact the treated iron absorbs about 120 ft./lb. without fracture. This cast iron will bend in the cold state without breaking. These results are almost sensational and indicate greatly extended uses in all engineering fields. Recognition of the value of this development will undoubtedly be rapid.

In this ductile cast iron the graphite is present in nodular or spheroidal form instead of the normal flakes and a much higher nominal stress will be reached before the local high stresses reach the yield stress and cause a permanent plastic deformation, its fatigue resistance, therefore, is of the same order as blackheart malleable iron.

British Industries Fair

Engineering Section at Castle Bromwich

The outstanding displays of British products at Castle Bromwich, and at Olympia and Earl's Court in London, are concerned primarily with the development of Britain's export industries. Although not completely representative they are very comprehensive and will prove invaluable to home as well as overseas visitors as a guide to progress in the industries represented. Apart from being a shop window for the display of products, the British Industries Fair provides opportunities for personal contacts not easily arranged in other ways and there is a feeling of confidence among exhibiting firms' executives that a further development of Britain's export objectives will result. In this pre-review attention is mainly directed to metallurgical aspects in the engineering section at Castle Bromwich.

THE British Industries Fair, which opens, at Castle Bromwich and at Olympia and Earl's Court, on May 8th, is the fourth to be held since the war, each of which has reflected stages in Britain's industrial recovery and her efforts to increase exports to the world's markets. The three sections are organised by the Government of the United Kingdom, the Castle Bromwich section in close collaboration with the Birmingham Chamber of Commerce and the London sections administered by the Commercial Relations and Export Department of the Board of Trade. As with the Exhibitions before the war, the Fair is an entirely national effort designed to display the resources of the British Commonwealth and to provide facilities for presenting to the world's buyers the developments of British industry. Since its inception in 1915 it has been concerned mainly with developing overseas trade, during the last three Exhibitions, however, this aspect has been intensified because the war consumed practically all Britain's overseas assets from which she had previously obtained a useful measure of food and raw materials, necessitating a much greater proportion of her products being sold in overseas markets than before the war. This need is just as vital to-day and there is quiet confidence that the present display will further enhance British reputation abroad.

This year's Exhibition occupies more space than in previous years: at Castle Bromwich, for instance, the outdoor section has been considerably increased. Since the initial venture it has grown considerably to cope with the increasing number of exhibitors, but it is not yet fully representative of the industrial facilities available, nor is it likely to be until agreement is reached regarding the desirability of including a number of other important industries, notably machine tools, shipbuilding and marine engineering, and aeronautical engineering. In its present form, however, the problem of housing the exhibits is of considerable magnitude and any additions, other than token displays, would probably prove insurmountable.

An innovation in connection with the present Fair is a Gala organised by The Institute of Export, to take place on May 12th, at the Empress Hall, Earls Court. This will provide an opportunity for exhibitors and buyers to get together in informal "off duty" association for an evening of dancing and cabaret entertainment. It is hoped that this initial attempt to promote a national Gala side by side with a national Trade Fair may be the means of establishing a tradition such as that which attaches, for instance, to the Chelsea Arts Ball.

In reviewing the exhibits of such a comprehensive Exhibition to assist buyers at home and abroad, especially those unable to visit the Fair, much more space would be needed than can be given here. So many technical advances are displayed that only a representative cross-section of Britain's productive effort can be attempted, but as we are more concerned with the production and use of metals, attention is especially directed to the Castle Bromwich section of the Fair where engineering and hardware exhibits are housed and an effort made to describe briefly some of the many interesting features.

Wrought Steel

The curve of steel production by the British Steel Industry continues on its upward trend, a fact which is strikingly brought home to the visitor by the BRITISH IRON AND STEEL FEDERATION'S Stand (D 631/530), on which a glowing model ingot will be illuminated at intervals of 2 seconds, to indicate that another ton of British steel is made. This timing has been calculated on the basis of steel production for the first quarter of 1950, which was at an annual rate of over 16,000,000 tons, roughly equivalent to 1 ton of steel being made every 2 seconds day and night throughout the year. A further striking exhibit will be a composite coloured photographic transparency, 11 ft. 6 in. × 7 ft. 6 in., and believed to be the largest ever attempted, showing a cogging mill in action.

The main function of the stand will be to provide a centre for consultation on all iron and steel matters.

The products of the ENGLISH STEEL CORPORATION shown on Stand D 541/438 will include a range of discs in various stages of manufacture for the De Havilland "Ghost" jet engine and a range of finish-machined crankshafts for internal combustion engines. Also exhibited are coil and laminated springs for road and rail vehicles, torsion bars, and wheels and axles for railway rolling stock.

Forged steel drill collars and substitutes and a range of rock bits for the deep drilling of boreholes for oil are also included. As the U.S.A. had almost a monopoly in the past, their manufacture under licence from the English Drilling Equipment Company is a useful contribution to the national economy.

Courtesy of David Brown-Jackson, Ltd.

Hobbing rolling mill pinions.

To illustrate the products of the Manchester Works, there is a model of an H.F. electric furnace continuously pouring liquid, to represent molten steel, into a ladle from the bottom of which come tool steel blanks leading to a wide range of finished engineers' tools. Other products of this branch are permanent magnets for all purposes.

The aim of the UNITED STEEL COMPANIES' Stand (D519) is to present a general picture of the wide diversity of their steel production rather than to attempt to display the whole of their products. Three working models which illustrate the production of iron and steel at the Appleby-Frodingham branch are sure to create a considerable amount of interest both with the general public and the more technically minded visitors.

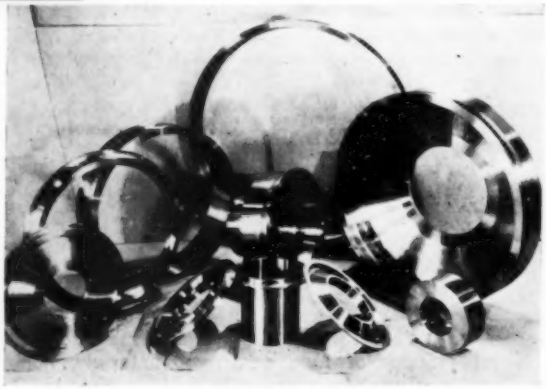
A feature of the display will be Silver Fox stainless steel, produced by the Samuel Fox & Co., Ltd. branch, in the form of cold-rolled strip, sheets, and tubes, while the Steel, Peech & Tozer branch will be represented by a large roller forging and other heavy forging products of a like nature. There will also be a steel assembly showing their solid wheels and axles for railway work and this assembly will be mounted on rails with steel sleepers as produced by the Workington branch.

Since the days when the late Harry Brearley invented what he described as "knives that won't cut," the name Firth has been associated with stainless steel. More recently in association with the English Steel Corporation, FIRTH-VICKERS STAINLESS STEELS, LTD. came into being and is now responsible for the "stainless" business of the two companies. Exhibits on Stand D 419/320 will include stainless and heat-resisting steels in the form of sheet, strip, bars, forgings and castings.

A special display of the products of the EXORS OF JAMES MILLS, LTD. will be made on Stand D 400/503 as this year marks the centenary of the Company's formation. The earliest venture of the Company, the making of engineers' keys, will be represented in the exhibits along with pins, cotters, and large scale models of grooved pins and studs.

Special features of the stand are a display of some of the 1,600 special shapes in bright drawn steel bars, which save machining and assembly costs in a wide range of engineering products, and a working scale model railway track complete with rolling stock. The track comprises the bull-head rail type fitted with Mills steel keys, and the new flat-bottom rail now being extensively installed in this country and fitted with Mills' jaws and Macbeth spike anchors for securing the rail to the sleepers.

Almost daily some new use is being found for stainless-steel wire and cold-rolled strip, both in the home and export markets. At home the developments in the use of stainless are really remarkable, and whilst the same circumstances are not noticeable for overseas markets, there is nevertheless a continually growing demand, stimulated by an extended range of sizes of cold-rolled steel strip now produced by LEE OF SHEFFIELD, LTD. On



Courtesy of Firth-Vickers Stainless Steels, Ltd.

A group of centri-die and centrifugal castings.

Stand D 528 there will be a display of articles made from stainless-steel strip and wire illustrating the wide range of applications.

On Stand D 208, the exhibit of BRITISH ROLLING MILLS, LTD., manufacturers of bright steel strip, bars and sections, will take the form of a demonstration of the methods adopted by the Company's laboratory staff to maintain the excellence of the product. These will include the use of the magnetic sorting bridge to eliminate the mixing of qualities; the photo-electric absorptiometric method of chemical analysis; the Vicker's projection microscope which is capable of magnification up to 2,500 ×; and the Rockwell hardness tester.

Anchors and cables made at Netherton Iron Works by N. HINGLEY & SONS, LTD. have been supplied to shipping sailing in every sea and Netherton Iron in its well-known brands, including Netherton Best Yorkshire, has been distributed to every market for railway engineering and agricultural use. The exhibits displayed on Stand D 255 will include model anchors, samples of puddled wrought iron, chains, hooks and smith work. Small model anvils, representative of the range of "all

steel" anvils manufactured, and forgings and drop forgings for the general engineering and shipbuilding trades, including both welded and weldless steel rings, will also be displayed.

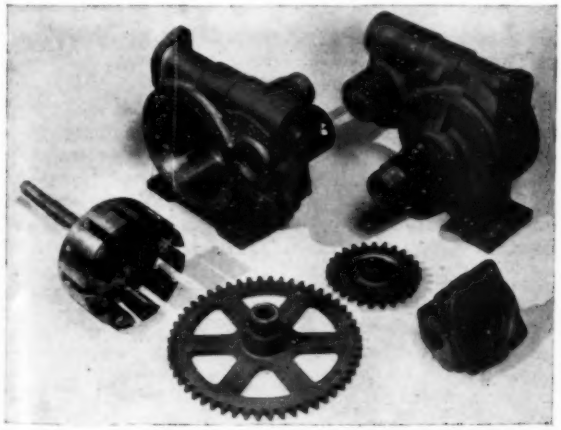
On the BROCKHOUSE GROUP, Stand (D 405/304), J. BROCKHOUSE & CO., LTD. will exhibit axles and springs for transport equipment; specimens of carbon and alloy-steel drop forgings, from a few ounces up to 150 lb. in weight; and forgings from horizontal upsetting machines. Hot-rolled angles will be shown by the DISTRICT IRON & STEEL CO., LTD., railway iron and steel work by LONES, VERNON & HOLDEN, LTD., and specimens from the range of 8,000 cold-rolled sections manufactured in steel, brass, aluminium, Sheradized steel, Bonderized steel, sealed steel and self-colour steel by the WARWICK RIM & SECTIONING CO., LTD.

The THOS. W. WARD, LTD. Group will exhibit its products on two stands, D 719 (indoor) and 1360 (outdoor). The indoor stand will display photographs of those aspects of the group's operations which cannot be exemplified by actual machines or equipment. The activities depicted will include factory planning and installation work, industrial dismantling, shipbreaking, scrap handling, railway constructional work, erection of structural steelwork, roadmaking and the like. Of the photographs shown, the series on the shipbreaking yards are of exceptional interest, depicting as they do, famous fighting vessels being brought to a final berthing to be broken up for the valuable scrap they yield.

As regards the outdoor stand, the display will consist of examples of the range of machinery and industrial plant marketed by the Parent Company together with unit displays showing the activities and products of the subsidiary companies. Exhibits will include sheet metal working machinery, woodworking machinery; pumps and compressors; and various items from the "Polford" range of foundry plant, for which Wards are sole selling agents.

On Stand D 422, PADLEY & VENABLES, LTD. will exhibit stainless steel in the form of sheet, strip, bar, tube, sections, wire and castings, together with demonstrative applications made from these materials.

The products to be displayed by LINREAD, LTD. on Stand D 221 have been chosen to illustrate Linread leadership in cold forging. They include a wide selection of normal and high-tensile screws and bolts with hexagon, slotted and Phillips' recessed heads. A number of cold forgings are also shown and parts made from medium and high-tensile steels, stainless steels, brasses, light alloys, Monel and other alloys are included.



Courtesy of John Harper and Co. Ltd.

A group of cast-iron pump parts.

Courtesy of K. & L. Steelfounders & Engineers, Ltd

A group of cast steel locomotive wheel centres.

A group of small high-precision components of complex shape illustrates some of the possibilities of an entirely new metal cold-forming process which is exclusive to Linread. A further exhibit concerns the patent Linread Rivnut which combines the functions of blind rivet and captive nut and the display is completed by a selection of typical auto turned and pressed parts.

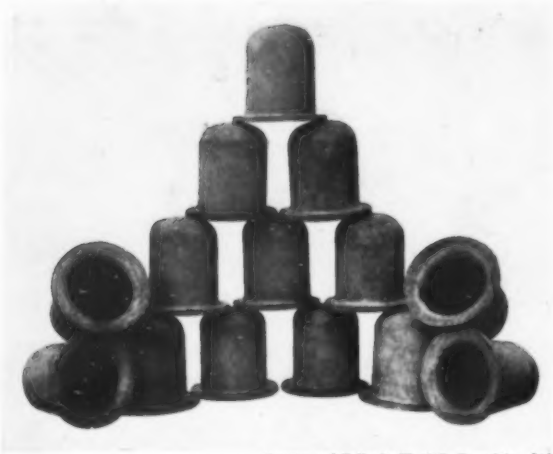
Attention is also drawn to the stands of RICHARD THOMAS & BALDWIN, LTD. (D 301/200), makers of a wide range of flat rolled steel products, steel sheet, tinplate, stainless steel, etc. Other products include electrical sheet steel, galvanised sheet, merchant mill products, and aluminium sheets, etc.

On Stands B 629/526 and Outdoor 1321/1220, GUEST KEEN & NETTLEFOLDS (MIDLANDS), LTD. and GUEST KEEN & NETTLEFOLDS (SOUTH WALES), LTD. will be exhibiting their range of products which includes nuts, bolts, screws, washers, pins, cotters, self-tapping screws, rivets, bushes, etc., and hot- and cold-rolled steel bars and sections, wire rods, grey iron castings and fireclay refractories.

Ferrous Castings

The Steel Foundry Department of EDGAR ALLEN & CO., LTD. (Stand D 534) will have a most interesting exhibit in the form of a large cast steel locomotive driving wheel mounted on the same shaft as a much smaller wheel of the same type, the latter as supplied to one of the toy railways to be found on our coasts. This will be shown revolving at a slow speed. In addition there will be a large traction yoke casting in high permeability steel, weighing about 2 tons and measuring some 5 ft. 1½ in. long by 31 in. wide.

The one piece cast steel bogie, made by the ENGLISH STEEL CORPORATION, LTD. for an electric motor coach for the New Zealand Railways, and shown on Stand D 541/438, is one of the first one piece bogie frames ever made in this country. The cast steel motor casings and bolster of this bogie are also made by E.S.C.



Courtesy of Follsain-Wycliffe Foundries, Ltd.

Pressed steel cyanide pots " Penetral " treated.

Of more than usual general interest on Stand D 343 is an 11-ton rolling mill pinion from DAVID BROWN-JACKSON, LTD. It is the first hobbed roll pinion to be shown in this country and emphasises the importance which David Brown's attach to this improved method of cutting these heavy duty rolling mill pinions. Normally, rolling mill pinions are end milled, but the more precise process of hobbing endows the mill with a smoothness of operation hitherto confined to high-speed precision machinery and, because of the greater degree of accuracy, results in a more even distribution of load over the teeth, giving the pinions a longer life.

This same foundry is also showing a 14-ton roll for roughing scale breaker, cast in carbon steel, as typifying the capacity of British foundries to produce such goods, which only a few years ago were largely of foreign origin. The roll shown is for the Welsh mills.

On the same stand the DAVID BROWN FOUNDRIES COMPANY are exhibiting a turbine casing to symbolise their interest in the specialised field of turbine castings and have also sent forward a wide variety of castings in bronze, stainless, high-tensile, heat-resisting and " aircraft quality " steels and precision castings made by the investment process.

A selection of the high-grade steel castings manufactured by K. & L. Steelfounders and Engineers, Ltd., Letchworth, Herts., will be exhibited in the " 600 " Group Pavilion (Outdoor Stand 1334). This will include examples of various types of locomotive wheel centres. The K. & L. exhibit will also include " Coborn " cast steel anvils from 14 lb. to 4½ cwt.

Stainless-steel castings will be shown by PADLEY & VENABLES, LTD. on Stand D 422 and by FIRTH-VICKERS STAINLESS STEELS, LTD. on Stand D 419/320. The latter display will include castings made by the centrifugal method, the centri-die method, and the precision method.

On Stand D 405/304, BROCKHOUSE CASTINGS, LTD. will be showing specimen iron and steel castings varying from a few pounds to more than a ton in weight, whilst R. J. HUNT & SON, LTD. will display grey iron and repetition castings.

Included in the subsidiary companies of THOS. W. WARD, LTD. (D 719 and 1360 Outdoor) are three producers of castings. DARLINGTON RAILWAY PLANT & FOUNDRY CO., LTD. make castings up to 30 tons in weight, JOHN WILLIAMS (WISHAW), LTD. are makers of iron castings, and THE WIDNES FOUNDRY & ENGINEERING CO., LTD. are producers of specialised castings and fabricated vessels for the chemical, gas, oil, food and allied industries in ordinary and special irons and in mild and stainless steel.

Cylinder liners, centrifugal castings and chromium-plated liners will be shown in a wide range of sizes by the SHEEPBRIDGE-STOKES CENTRIFUGAL CASTINGS CO., LTD. on Stand D 142. These include liners for petrol and compression ignition engines, compressors and pumps in their Centricast range of alloy irons. This concern will also show examples of sand-moulded castings, alloy-cast steels, nickel-base alloys, machined Centricast rollers and drums, and die-cast iron rod in lengths of up to 6 ft.

The increasing use which industry is making of Permalite, the high-duty alloy developed recently in the laboratories of HALE & HALE (TIPTON), LTD., will be demonstrated by a display of castings in this special purpose metal to be featured on this firm's stand, D 609/508. Designed to withstand excessive shock and abrasion, castings in Permalite are now being used as reliable and cheaper alternatives to steel for rear axles, brake drums, differential cases, etc., by leading manufacturers of heavy commercial vehicles—by the electrical industry and by manufacturers of agricultural equipment and machinery. Permalite belongs to the pearlitic class of malleable iron and has a tensile strength of 32–35 tons/sq. in., a yield point of 19–22 tons/sq. in. and an elongation of 6–8%. Experience over the past two years has demonstrated that its introduction has greatly widened the application of malleable iron, and practical examples of parts for which it has been adopted will show that it can be seriously regarded as an alternative to cast steel, with added advantages in cost, finish and machinability.

Other exhibits will include machined and unmachined castings in Blackheart malleable iron for the mining, shipbuilding, electrical, rail and road transport, building and agricultural machinery industries. Among the new products of interest to the mining industry will be a compact, wedge-type pit-prop head developed to meet a demand for a simpler, lighter and more economical head than that supplied with Hale's standard wedge-type prop.

Of considerable interest to production engineers is the display of grey-iron and Harper-Meehanite castings on the stand of JOHN HARPER & CO., LTD. (A 334). Amongst the grey-iron castings on show are examples for typewriter frames, automobile accessories, sewing machines and automatic scales, all of them intricate and all produced to fine tolerances. In the Harper-Meehanite section several high-duty cast-iron parts are shown which have been used successfully in the place of steel or malleable irons. Harper-Meehanite cast-iron sticks are also displayed, together with a selection of components which have been machined from them.

A wide variety of exhibits will be displayed by FOLLSAIN-WYCLIFFE FOUNDRIES, LTD. on Stand D 709, including castings in Blackheart malleable iron and CY abrasion resisting alloy which lasts three to five times longer than a good chilled iron for this purpose. Of special interest to heat-treatment engineers will be examples of hearth grids, carburising boxes, gas-

carburising plant spares, etc., cast in E.V. nickel-chrome heat-resisting alloy. The Company's Penetral treatment of mild steel to render it resistant to oxidation for temperatures up to 1,000° C. will be shown in the form of carburising boxes, cyanide pots, trays for heating and quenching batches of forgings, pyrometer sheaths, etc. An unusual exhibit shown for the first time at the B.I.F. is a dumper bar consisting of a main portion in heat-resisting iron with a special tip in E.V nickel chrome steel which is easily detached.

As will be seen from the exhibits referred to in this section, the development of alloy cast irons, malleable cast iron, and straight-cast irons with greatly improved structures has led to an increasing use of the material in engineering construction. All these developments have increased the importance of refined irons in the foundry industry and the importance of the quality and characteristics of refined irons. On Stand B 517/416, BRADLEY & FOSTER, LTD. will be exhibiting various brands of refined pig iron which include cylinder irons, cold blast irons, malleable iron and a range of alloy irons. Other exhibits will include abrasive shot, examples of high-silicon acid-resisting castings and wear-resisting castings.

The display of the products of the STAVELEY IRON & CHEMICAL CO., LTD. on the same stand will include vertically cast iron pipes, sand spun pipes and metal spun pipes, together with Staveley pig iron, a number of special pipes and a range of chemical products.

Malleable iron castings comprise the exhibits on Stand D 513/410 where LEYS MALLEABLE CASTINGS, LTD. will display a range of automobile, agricultural, electrical and general engineering castings in Ley's Blackheart Malleable Iron (tensile strength, 24 tons/sq. in., yield strength, 16 tons/sq. in.) and Leys " Lepaz " Pearlitic Malleable Iron with a tensile strength range of 35–70 tons/sq. in. Features likely to appeal to designers are the intricate shapes possible in a material having rigidity and shock resistance.

The metal products of the STANTON IRONWORKS CO., LTD. will be shown on Stand E626/717 and the display will consist of Stanton spun iron pipes, special castings, concrete-lined spun iron pipes, flexible joints for gas water mains, and a range of pig iron. Of considerable interest will be an array of historic pipe exhibits, whilst a further feature will be the projection of a film showing manufacturing operations.

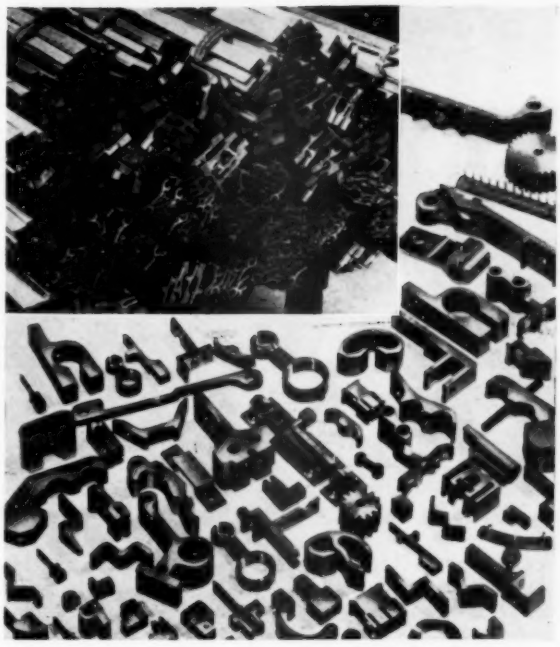
Foundry products of FERRANTI, LTD. exhibited on Stand C 615/514 will include examples of both large and small castings together with castings made in Nomag, Ferranti's non-magnetic cast iron.

Precision casting continues to make progress and on Stand C 327, B.I.P. TOOLS, LTD., a member of the BRITISH INDUSTRIAL PLASTICS GROUP, will show the various stages in precision casting together with a number of precision-cast mould parts.

Non-ferrous Metals

As in previous years, the BRITISH NON-FERROUS METALS' FEDERATION is maintaining a Stand, D 219, which will be in the nature of an information bureau on all matters concerning the non-ferrous metals industry.

Visitors and exhibitors alike will profit by a visit to Stand D 230, where they will learn of the unrivalled technical services offered free by the COPPER DEVELOPMENT ASSOCIATION to all users of copper and copper alloys. The C.D.A. possesses a wealth of information on the properties of these materials and on service experience with them. In addition a vast amount of metallurgical data on the casting and working of copper and its alloys is available and about 40 technical publications are issued free to those who can profit by the accumulated knowledge they contain.



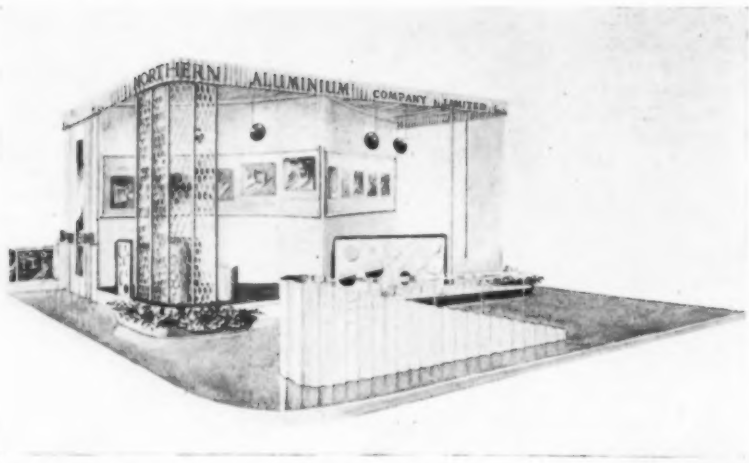
Courtesy of McKechnie Brothers, Ltd.

Components made from extruded sections. Inset—extruded sections ready for dispatch.

The hundreds of tons of hard drawn high conductivity bus-bars manufactured each year by THOMAS BOLTON & SONS, LTD., in various sizes up to 10 × 1 in. thick, is but an indication of the Company's contribution to the country's output of electrical equipment. Manufacturers of copper and copper-base alloys since 1783, Bolton's have paid considerable attention to the development of materials for use in the electrical industry. Included in the products displayed on Stand D 745 will be " Combarloy," a special alloy for commutator segments which is made in various forms by shaping, stamping, etc.; rail bonds for electric traction; 2- and 3-pole equaliser bars; and the 10 × 1 in. bus-bars referred to above. Other exhibits will include wire and strip in copper brass and bronze; trolley wire sections; tubes (which will play an important role in the construction of the stand); extruded and drawn sections; and machined parts. " Bush " Brand chill-cast phosphor bronze solid and cored bars and tungsten carbide drawing and extruding dies made from B.T.H. " Ardoloy " complete the display.

Sixteen thousand different shapes of non-ferrous extrusions are made by MCKECHNIE BROTHERS, LTD., who will be showing a selective range on Stand D 515. Among the high-strength and corrosion-resistant aluminium bronze rods displayed will be a number made of " Narrmac," an alloy developed for jet engine components where high creep strength is essential.

Other examples of their products on view are: Bronze and nickel silver welding rods; brass wire in coils for



An artist's impression of the Northern Aluminium Company's stand.

re-drawing and cold heading; brass, bronze and white metal stampings; "Tank Brand" chill-cast phosphor bronze and gunmetal bars; non-ferrous metal ingots, including phospher bronze gunmetal, yellow metal, nickel silver, antifriction metal, Terne metal; and granulated cupro nickel.

The METALS DIVISION of IMPERIAL CHEMICAL INDUSTRIES, LTD. is staging a comprehensive display of its principal products—sheet, strip, tubes, rod, extrusions and wire, in copper, aluminium and their alloys—on Stand D 409/308.

A working laboratory unit shows how the Division employs spectrographic methods for the analytical control of its products. Photographs illustrate other specialised equipment which is used for research and control.

Another feature is a half-section of a double purlin roof built up from channels, angles and corrugated sheet in aluminium alloys. This particular type of roof was designed for use in tropical climates, and can be adapted to any building structure, whether of brick, stone or mud. This exhibit also includes a profile section of a secret-fix type roof employing aluminium alloy sheet and extrusions.

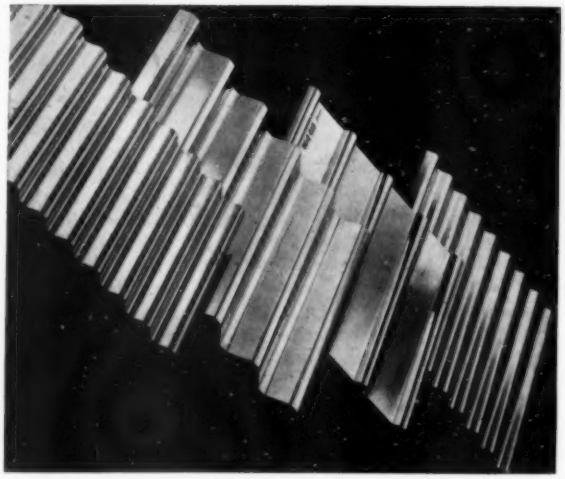
Yet another display demonstrates, by model and photographs, the method of laying "Kuterlon" copper tubes for underground water supplies by means of the mole drainage plough. Incorporated in the display will be a specially drawn ¾-in. diameter "Kuterlon" tube 120 ft. long.

The Hidurax series of aluminium bronzes in the wrought and cast forms figure prominently in the exhibits of LANGLEY ALLOYS, LTD. on Stand D 210. Widely used where high strength, and resistance to abrasion and corrosion are called for, these alloys also have a high-fatigue resistance. By a new process and careful manufacturing control a special Hidurax alloy is being made for gas turbine compressor blades and the high finish attained on samples exhibited is worthy of note. Other Hidurax exhibits will include pump and valve parts, gears, safety tools and wear-resisting bushes.

With mechanical properties much superior to those of copper and a conductivity of more than 80% I.A.C.S., Hidurel 6 castings and forgings find many applicatoins in switchgear and resistance - welding machines. Hidurel 5 is represented by exhibits including butt-welding dies, current carrying bushes and I.C. engine valve guides.

Castings in stainless steel, Monel nickel, Inconel and the Langalloy "R" series of nickel-molybdenum alloys complete the display. The Langalloy "R" alloys are intended for handling hydrochloric, sulphuric, phosphoric and organic acids at all temperatures, as well as for operation under oxidising conditions as occur with wet chlorine and some metallic salts.

Ancient and modern are linked together on Stand D 311, where the



British Aluminium's corrugated roofing.

DELTA METAL CO., LTD. are showing Delta Bronze No. IV cramps, dowels and tie rods, for the upkeep of the stonework of old buildings of historic interest, together with Delta welding rods for gas welding. These two exhibits illustrate too, the two main outlets for the Company's products—architecture and industry. No visitor can fail to be impressed by the quiet dignity and mellow effects produced by the use of sections in Delta Bronze No. IV and Delta No. 2 Silver Bronze in the construction of the stand and their strength and permanence are equally well known.

The main exhibits displayed comprise a large variety of brass, bronze and copper extruded sections; bars and forgings in Delta high-speed turning and screwing brass; Delta high conductivity copper and Delta high-grade engineering bronzes; and examples of Delta stamping rods, aluminium bronzes and other alloys.

Whether the visitor is interested in marine condenser tubes, copper tubes for domestic plumbing or copper alloy tubes for service in the sugar beet industry, he will find much to interest him on Stand B 723/634 where the YORKSHIRE COPPER WORKS, LTD. will be showing the many and varied applications of copper and copper-alloy tubing. A special display is made of "Yorcalbro"

Courtesy of the British Oxygen Co., Ltd.

The Mark III Argonarc welding torch in use.

condenser tubes and methods of fitting into the tube plates, while other marine exhibits show the use of copper alloy tubes in the plumbing layout of a modern liner and in various marine engineering applications.

Copper tubes for domestic and underground water pipes are coming into increasing use and further displays illustrate the use of "Yorcalon" copper tubes in long length coils of 30–60 ft. in length for underground water pipelines, together with a rapid method of laying which will be of immense interest for rural districts. Other displays concern tubes for the sugar industry, underground pipes after years of service, "Yorkshire" fittings and refrigerator tubes.

Large and heavy work in both tubes and plates is a speciality of the BIRMINGHAM BATTERY & METAL CO., LTD. and on Stand D 514, they will show a 5-ft. diameter × 6 in. thick yellow metal plate supplied to the oil industry, together with a 1-in. thick aluminium bronze plate and a 12 ft. × 8 ft. × 1 in. thick phosphor bronze plate as is now being manufactured for the artificial silk industry. Prominently displayed are large brass and copper tubes; condenser tubes in 70/30 brass; 70/29/1 alloy; "Batalbra" brand aluminium brass; 76/22/2 alloy; and the newer aluminium bronze and copper nickel iron alloys. For the building trade there are copper water service tubes, for indoor and underground use, together with copper roofing sheets. Other exhibits will comprise sheet, strip and wire.

A new development of the ROYAL MINT REFINERY (N. M. ROTHSCHILD & SONS) is very thin copper foil (down to 0·00012 in. in thickness) which is at present available from a pilot plant in sheets 30 in. × 5 in. Eventually it is expected that lengths of several hundred feet will be available in 7¼ in. widths. The foil is of hard temper and is easily handled in spite of its thinness. With a composition of electrolytic copper standard and a minimum conductivity of 95% I.A.C.S., it is supplied with one side polished and may, if necessary, have one or both sides plated with gold, silver, nickel, zinc, cadmium or tin. It is expected that the advent of this material will open up new possibilities in many industries, particularly those dealing with the manufacture of printed circuits and electrical condensers.

Items of interest on the ROYAL MINT REFINERY Stand, D 429, include non-ferrous strip, "Silberlink" silver solders, wires plated with non-ferrous and precious metals, and precious metals in other forms as required for industrial purposes, including gold salts. All strip is finished to very close limits and is electrically measured for the whole length of material, thus ensuring accuracy throughout. The special type of annealing employed results in a bright lustre finish as well as evenly controlled hardness.

Among the bronze castings and bushes made by JOSEPH TOMEY & SONS, LTD. (Stand D 703), an interesting product is a special lead bronze chill-cast stick containing 20% lead and 5% tin used for making special sealing bushes for a refrigeration plant. For this purpose the lead must be evenly dispersed in particles of not more than 0·001 in. diameter.

Castings in phosphor bronze, gunmetal, aluminium bronze, manganese bronze; railway axle box bearings; cored and solid bars; chill-cast phosphor bronze; machined bushes; and brazing solder are among the CHARLES CARR, LTD. exhibits on Stand D 604, whilst BARKER & ALLEN, LTD., on Stand D 507, will be showing nickel silver strip, sheet and wire in all qualities, together with cupro-nickel, brass and copper.

Brass, bronze, gunmetal and other copper alloy centrifugal castings in a range of shapes and sizes from 3 in. to 24 in. in diameter, will be shown by METALS AND ALLOYS (BIRMINGHAM) LTD. on Stand D 150, together with sand castings in sizes up to 1 cwt.

The plant of GUESTS BRASS STAMPING CO. is capable of producing large quantities of light and heavy work ranging from 1 oz. to several pounds in brass, copper, manganese bronze, etc. and a representative selection will be shown on Stand D 732.

The aluminium industry shows no signs of relaxing its efforts to maintain the important national position which it held during the war, and in no field is this more evident than in building, which accounts for one-fifth of the aluminium produced in this country. Much of this ultimately finds its way into the export market, particularly to tropical countries where its high reflectivity, low emissivity, durability under severe climate conditions and ease of transport make it a particularly suitable constructional material.

The BRITISH ALUMINIUM CO. LTD. will be represented on Stand D 605, where the exhibit purposely confines itself to two of the B.A. range of products, viz.: "Rigidal" corrugated sheet, and Super Purity Aluminium, both with particular application to the building industry. The former is proving suitable and safe for roofing and siding, particularly the new trough pattern designed for heavy duty service on large roofs. Its high thermal efficiency is important in agricultural buildings and its non-inflammability reduces fire risks, whilst where roofs are used for water catchment its non-toxic properties are an advantage. Super-purity aluminium sheet, which was referred to in our April issue, is refined by a double electrolytic process to

99·99% purity and is offered for such uses as flashings for which it is cheaper than other materials.

The NORTHERN ALUMINIUM Co. LTD. are making their £3,000,000 Rogerstone extension scheme, which will increase the country's aluminium sheet capacity by 35%, the theme of Stand D 629. This scheme will be completed this year and the layout and equipment will be shown by means of photographs. Adjacent to these will be examples of finished products ranging from toothpaste tubes to large motor body pressings. The use of aluminium in building is illustrated in the construction of the stand itself which incorporates many of the companies constructional products. Other exhibits will include examples of extrusions, castings and forgings both large and small and decorative finishes.

On TUBE INVESTMENTS Stands D 617/516 and D 619/518, T.I. ALUMINIUM LTD. will be showing aluminium and its alloys in the form of sheet, strip, plate, circles, tubes, sections and bar, including corrugated sheet and tread-plate. A clear indication will be given of the wide range of industrial purposes to which they are put and house building units in cold rolled aluminium sections will be shown. The stand itself will incorporate a number of new constructional ideas in the use of the Groups' products.

On the magnesium side, F. A. HUGHES & Co. LTD., on Outdoor Stand 1339/1238 will be showing, in addition to the standard magnesium anodes which are fairly common in this country for the protection of buried pipe lines, a number of new types of Elektron magnesium anodes, including a newly patented "booster anode" designed specially for the protection of structures in sea water. "Cathweld" connections which enable anode cables and bonding wires to be welded to pipe lines by lighting a powder placed in a small mould over the parts to be welded will be shown for the first time. In addition, there will be a wide range of types of anodes including those for domestic hot water tanks.

Pressure die castings in zinc-base alloy and pressure gravity die castings in aluminium alloy will be shown by KAYE ALLOY CASTINGS LTD. on the BROCKHOUSE stand, D 405/304, whilst C. & L. HILL LTD. on the OWEN ORGANISATION stand, D 616/717, will be exhibiting a selection of non-ferrous sand castings, chill cast phosphor bronze rods, aluminium gravity die castings and zinc base alloy tools for the production of sheet metal components.

Welding and Cutting Equipment

Electronics are now playing an important part in industrial control equipment and visitors will be interested in a demonstration of the electronic control of the deposition of weld metal on the stand of the METROPOLITAN-VICKERS ELECTRICAL CO. LTD. (C 510). A short gantry has been erected equipped with a rail track for a standard travelling carriage, which is complete with automatic welding head, operator's control panel and reel of coiled electrode. The electronic control is arranged to regulate the feed of the electrode to suit variations in the arc length, and the closeness of the control makes possible the use of a short arc, a high rate of deposition of metal, and thus a high welding speed.

Arc welding and arc cutting equipment comprise the exhibits of ROCKWELD LTD. on Stand D 537. In addition to arc welding plant, three new types of electrode

Cutting stainless steel by the Rockweld Oxyarc process.

will be shown. The Basac rod, suitable for welding high tensile steels, is available as Basac 35 and Basac 45 for 40 and 50 ton steels respectively. An entirely new type, the Sylvac rod is characterised by an extremely high rate of deposition and good mechanical properties, whilst the Lightac electrode has been specially developed for filling holes in steel castings and similar work.

By the use of the Oxyarc process, in which oxygen is passed through a hollow electrode, a hole can be punched through 1 in. mild steel plate in two seconds. The process can also be used for piercing and cutting cast iron, stainless steel, heat resisting steel, manganese steel and aluminium, whilst the tools used for washing away welds make the process eminently suitable for repair and maintenance work. Further exhibits: a new electrode holder, which fits into a British standard cable socket, and thermoplastics for the chemical and allied industries.

A selection of arc welding electrodes for use with mild steel, stainless steel, bronze, copper, etc., will be displayed on D 616/717 by INVICTA ELECTRODES LTD., a member of the Owen Organisation.

Since its introduction at the 1948 B.I.F., the Sciaky 75kVA "Three-phase" SAT. 75, Spot Welding Machine has undergone considerable development, and the latest machines now operating on production, have proved that the system has decided advantages over single phase plant. Apart from the high power factor (85% min.) its flexibility is an outstanding feature as light alloys up to two thicknesses of $\frac{1}{8}$ in., brass up to 12 s.w.g., galvanised and other coated materials up to 12 s.w.g., hard copper up to 16 s.w.g., as well as the thicker gauges of mild steel can be welded. Electrode "pick-up" is less than with a single-phase machine and welds of better metallurgical conformation are produced. Other machines exhibited on the stand of SCIAKY ELECTRIC WELDING MACHINES LTD. (C 222) will include the RAMU 50 Seam Welder and the SAC.25/2 High Speed Stitch Welding Machine.

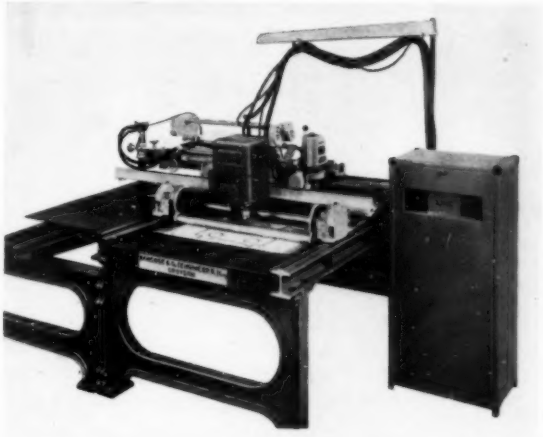
The representative display of B.I.C.C. Electric Resistance Welders will include bench and floor type

spot, butt and projection welders, fine wire welders and fine wire brazing machines, and Bicaloy electrodes for resistance welding. (BRITISH INSULATED CALLENDER'S CABLES LTD., Stand C 314).

The versatility of performance of the Nos. 1, 2 and 3 Butt Welders shown by HOLDEN & HUNT LTD. on Stand C 618/719, is demonstrated by their ability to deal successfully with silver, copper, brass and aluminium and its alloys, as well as the more usual ferrous materials.

Among the wide range of products exhibited by CROMPTON-PARKINSON LTD. on Stand C 609, there is one item of particular interest to readers, viz.: the Nelson Stud-Welding Gun for end welding studs in less than one-tenth the time taken to drill and tap one fixing hole. Only 5 lb. in weight, it has a wide application in ferrous metal-working industries. Automatic timing reduces the operator's work to locating the gun and pressing a button.

To serve the increasing use of light metals in industry, CYC-ARC LTD. (Stand C 218) have now perfected the



Hancock oxygen cutting machine with electronic head.

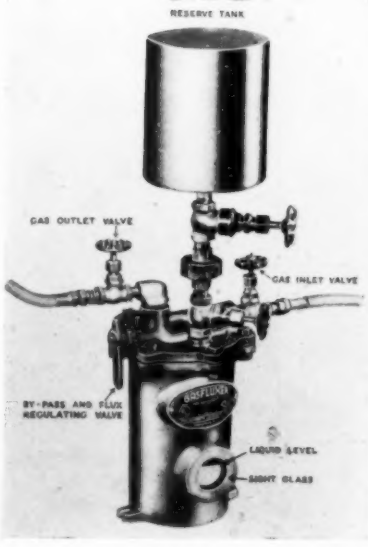
stud welding of aluminium alloys, an event of considerable importance to fabricators. No special accessories are needed, the standard E1/D equipment will perform the operation satisfactorily. Amongst the equipment shown will be the "D" type Handtool, capable of welding studs from $\frac{1}{8}$ in. diameter or less and up to $\frac{5}{8}$ in.; the "F" type Fixed Welding Head, designed primarily for modern mass production, and the E1/FM Universal Stud Welding Machine Tool which is a self-contained unit designed primarily for high-speed repetition work which can be brought to the machine.

An outstanding feature of the Cyc-Arc equipment is the controller incorporating the Patented Pilot-Arc system enabling welding to be successfully carried out despite the presence, at the welding site, of moderate coatings of rust, mill scale or paint.

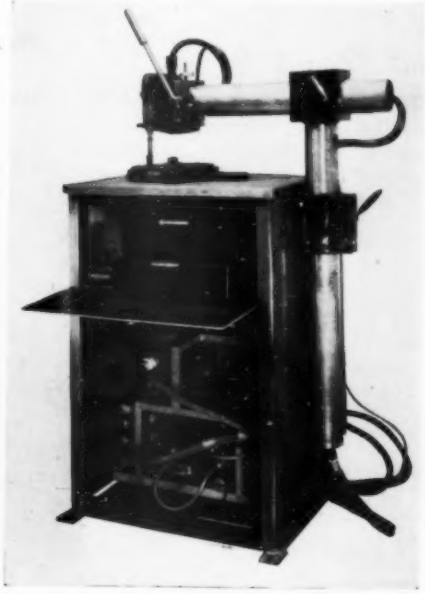
Symbolised on Stand D 100/201 by a rotating centre-piece in the form of a large stainless steel cube fabricated by the process, Argonarc welding, developed in this country by THE BRITISH OXYGEN CO. LTD., is rapidly attaining a position of paramount importance in those industries concerned with the fabrication by welding of stainless steel, aluminium, magnesium, copper, nickel and their respective alloys. The Argonarc process is the only known method of fusion welding light alloys without the necessity of using a corrosive type of flux. Equipment to be demonstrated will include the Mark II Torch for light gauge work and the Mark III Water Cooled Torch which permits metals up to $\frac{3}{8}$ in. in thickness to be welded in a single pass. Machine Argonarc welding will be covered by exhibiting the latest type of Mark IV Argonarc portable welding machine. This machine has been designed to meet the need of high speed continuous welds in light gauge materials and, from the point of view of mass production of stainless steel, aluminium, magnesium and other metal products, is worthy of special attention.

Demonstrations will be given of the Company's oxyacetylene welding equipment and oxygen cutting machines, whilst of great interest to fabricators in stainless steel plate will be the powder cutting equipment used for stainless steel and certain non-ferrous metals which will be displayed along with samples cut by the process.

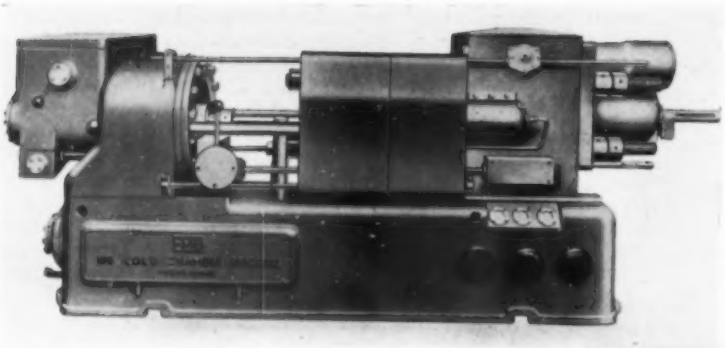
Stand D 739/638 is shared by HANCOCK & CO. (ENGINEERS) LTD. and WELDCRAFT LTD. The former, who specialise in the manufacture of oxygen cutting machines will be showing one of their well-known U-arm machines, a range of pipe cutting machines, a portable machine for plate cutting, and a flame planing machine for plate edge preparation for welding. Probably the most interesting machine will form the subject



Weldcraft Gasfluxer.



Cyc-Arc Type E.1/F.M. universal stud-welding machine tool.



E.M.B. No. 9 cold chamber machine for aluminium die castings up to 3½ lb. in weight.

of a demonstration. It is a longitudinal profiling machine fitted with an electronic tracing head. With this machine, the electronic side of which was perfected by the Metropolitan-Vickers Electrical Co. Ltd., it is possible to cut a given shape provided an outline drawing (with lines ¼ in. thick) is available. A spot of light is projected on to the line and the electronic head then keeps the spot on the line as the torch progresses.

WELDCRAFT LTD. are showing a range of " Aut-o-Cet " gas welding equipment, including blowpipe, regulators and generators, " Sight-feed " acetylene generators and the " Fluxcraft " gas fluxer. The last named is a very interesting development in the bronze welding field. Liquid " Gasflux " is inducted into the gas line and is discharged through the torch with the flame. It is claimed that variations of under and over fluxing which can occur with powder and paste fluxing are impossible, that good strong non-porous welds result and that finishing costs are greatly reduced.

For light welding, the " Flamemaster " gas hand torch will be exhibited by CHANCE BROTHERS LTD. on Stand D 540. Weighing only 12 oz. it can be used with gas/air or gas/oxygen. Seven interchangeable flame units are available and it has a built-in leak-proof economiser.

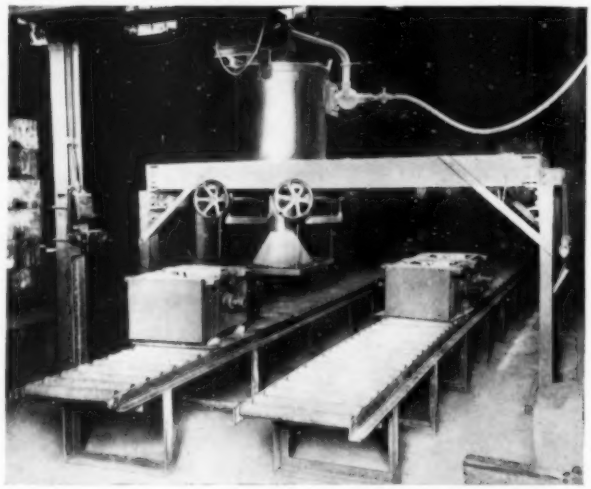
Rolls for Rolling Mills

The continued need for improvement has presented new and difficult problems to the roll maker. Such opposed characteristics as hardness and toughness, wear resistance and heat resistance, rigidity and flexibility, must be combined to give the optimum results. The Research Department, foundries, and machine shops of THE BRITISH ROLLMAKERS CORPORATION LTD. are constantly engaged in such development work, and their combined facilities, plus a long experience, result in the production of rolls, the highest qualities of which satisfy the most exacting mill manager. The names of TENNENT, AKRILL, PERRY and BAYLISS are known among mill operatives all the world over. Combined as The British Rollmakers Corporation Ltd. they constitute the largest producers of cast rolls in Britain.

Examples of a wide size and quality range of product are shown on Stand D 517. Included in the exhibits is a 4 in. diameter straight carbon chilled roll, weighing 28 lb. for cold rolling nickel silver, a representative range of rolls of varying sizes for hot and cold rolling ferrous and non-ferrous metals both flat and grooved, in straight carbon, alloy clear and alloy indefinite chill qualities, and an R.B.T. special alloy steel hollow cast backing-up roll, 46 in. diameter, weighing 18 tons. A series of photographs, illustrating some of the largest rolls made for the rolling of plates, both in cast iron and alloy steel, some of the plant used in roll manufacture, and the metallographic structure of roll metals will also be displayed.

Foundry Equipment

One of the most important factors in the production of aluminium die castings which are sound and of good finish is the speed of operation. The die cavity must be completely filled before any of the metal freezes, which means that the highest possible speed of injection must be available. Suitable for castings up to 3½ lb., the No. 9 Cold Chamber Machine, shown by the E.M.B. Co. LTD. on Stand D 238, uses the high speed of compressed air under hydraulic control. Any practical speed of injection can be obtained—the time required to fill the die is variable from 1/10th second down to the slowest speed likely to be required irrespective of pressure. The machine is completely guarded and interlocked and operation is by a single lever adjacent to the pouring position. Gas burners are provided to heat the die and metal cylinder initially. The machine exhibited will be under air power to show the operational cycle.



Courtesy of Modern Furnaces and Stoves, Ltd.

" Newstad " patent gas-fired skin drying plant.

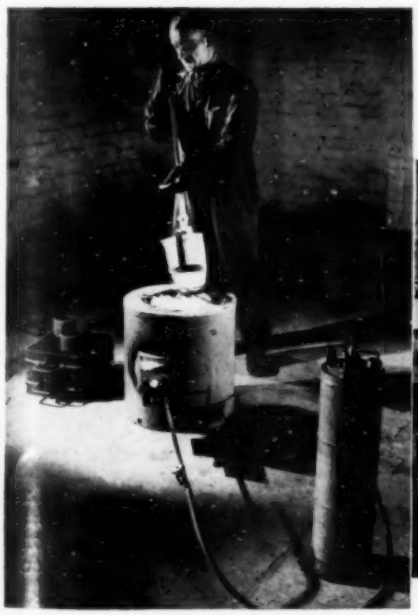
On Stand D 310, ALFRED HERBERT LTD. will have two die-casting machines on view. The Herbert-Reed Prentice 1½ Z Slot Chamber Die Casting Machine for zinc-base alloys has available a locking pressure of 130 tons, enabling large areas to be cast. Pressures from 1,000 to 3,500 lb./sq. in. can be obtained in the metal and the area of casting is up to 305 sq. in. Other features include built-in core pulling equipment, automatic casting ejection, manual and semi-automatic operation, and gas-fired furnace with pyrometric control. For castings up to 1¼ lb. in aluminium, brass and magnesium, the Edgwick A.1611 Cold Chamber Die-casting Machine will be shown. The locking pressure is 50 tons, and the maximum area of casting at 7,400 lb./sq. in. is 13½ sq. in. Hydraulically operated, a nitrogen bottle is provided to

give a higher speed to the injection stroke than the pumps could provide.

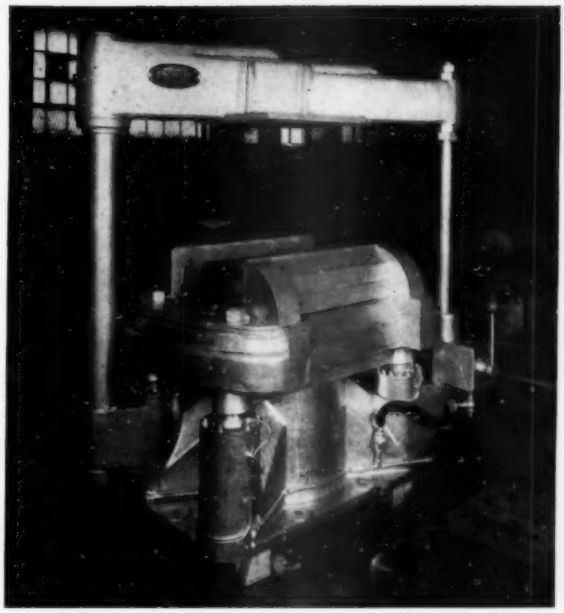
Of the foundry equipment displayed by PNEULEC LTD. on Stand D 626, greatest interest centres in a new jarr squeeze strip machine. This is shown for the first time at any exhibition. It is a development of a smaller size and incorporates a number of improvements. The new machine, described as a No. 660, is designed to take boxes up to an area of 660 sq. in. The normal maximum box size is 30 in. × 22 in. with a pattern draw of 8 in. The squeeze piston is 18 in. diameter, and the jarr piston 8½ in. diameter. This machine, which strips on the return down-stroke after squeezing, has the stripping mechanism operated pneumatically. A further development is the arrangement of the stripping rails, which are made adjustable in and out to suit the width of the box. Other items of equipment included are a 375 jarr squeeze stripper, Pneulec Royer sand mixing machines in various sizes and types, and a bumper of a 36 in. × 48 in. jarr rollover pattern draw installation.

A 1½-ton oil-fired, fully mechanised, rotary furnace for melting iron, steel and non-ferrous metals will be shown by the MONOMETER MANUFACTURING CO. LTD. on Stand D 731. Other furnaces exhibited on this stand include a 10–15 cwt. semi-rotary furnace, with offset pouring, suitable for non-ferrous work; a new type stream-lined 600 lb. top pour, central axis tilting furnace (power driven); a new type stream-lined oil-fired aluminium bale-out furnace; an oil- or gas-fired lift-out crucible furnace for non-ferrous metals; and a 500 lb. gas-fired lead bale-out furnace.

A number of different types of melting furnaces will be exhibited by LEES HALL & SONS LTD. on Stand D 115. These include the F.3, gas- and oil-fired furnace specially designed for aluminium bronze melting; lift-out crucible furnaces arranged for gas- and oil-firing or for coke-firing with indestructible fire bars and drop bottom; gas- and oil-fired bale-out furnaces for non-ferrous metals; gas- and oil-fired central axis tilting furnaces with capacity



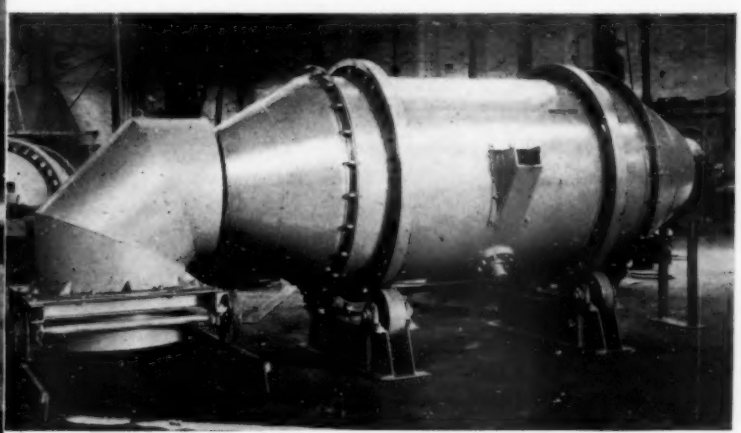
Morgan miniature crucible furnace.



Pneulec S.S.660 jarr squeeze strip machine.

400/600 and 1,000 lb. brass; gas-fired furnace for lead alloy melting; 10–15 cwt. Junior Cupola; standard 2-ton cupola with independent air tuyeres operated with air controls independent of the air distributing belt; F.4 pre-heated air 10 cwt. aluminium bale-out furnace; and a wide range of melting accessories such as burners, fans, crucibles, etc.

MODERN FURNACES & STOVES LTD. specialise in core and mould drying equipment and a number of their lines will be shown on Stand D 755. Of particular interest is the "Newstad" patent gas-fired skin drying plant for foundry moulds, which allows of drying moulds for steel, iron and non-ferrous castings, to a sufficient depth for good castings to be made from them, in 4–10 minutes. Uniformity of temperature is achieved in the gas-fired "Traykor" core drying stove exhibited by circulation



Courtesy of the Monometer Manufacturing Co., Ltd.

No. 1 complete rotary furnace.

of the hot air on the " Newstad " recirculation system. Other exhibits include " Newstad " vortex gas burners and a gas-fired " Newstad " recirculating heating unit suitable for heating a number of core drying chambers.

Foundry equipment made by the MORGAN CRUCIBLE CO. LTD., will be shown on Stand D 305/204. Space does not permit the showing of any of the large crucible furnaces but two items of interest will be on the stand. The Morgan Miniature Paraffin Crucible Furnace is a cheap and handy unit for quick small melts of all common non-ferrous alloys. It is self contained and easily portable and its performance can be gauged from the fact that it will melt 32 lb. of brass in 25–30 minutes. The tank holds sufficient paraffin for four melts. There is now available a gas-fired version of this unit. When crucibles are used as ladles or when they have to be inserted in a hot furnace, preheating is necessary. The Morgan Crucible Heater has been designed to perform this operation in a regulated and uniform manner. Other exhibits of interest to the foundryman will be a range of refractory (including plumbago) accessories such as tundishes, plunger mixers, bricks and shapes, crucibles, etc. Of special interest will be the plumbago knock-off riser plates. Consisting of a circular disc with a central hole, they are inserted in the riser to leave a narrow neck between casting and riser and, without impairing feeding, they reduce the amount of metal to be sawn through or fractured in removing the riser.

For many years now, Wyoming Bentonite has been regarded as one of the best foundry bonding agents and before the war considerable quantities were imported from the U.S.A. Shipping difficulties during the war and dollar difficulties since, led to a search for a substitute. COLIN STEWART, LTD., who are exhibiting on Stand B 601, investigated the properties which make for the success of Wyoming Bentonite and then carried out a world-wide search for an alternative source of supply. After many disappointments a large and satisfactory deposit was discovered in the Mediterranean region and visitors will be able to see this material in lump and ground form on Stand B 601. Other exhibits will include silica, vermiculite, barytes, manganese dioxide, zircon, talc, sillimanite, fluorspar, etc., all in ground and lump form.

A selection of foundry sand cores, bonded with Beetle Resin W.20, will be featured by BEETLE BOND, LTD. on Stand B 402. W.20 is a liquid urea-formaldehyde synthetic resin designed for use as a core-binder. The resin hardens on baking to an insoluble and infusible state.

For the purpose of sand cleaning, foundrymen will be interested in the various types of magnetic separator shown on the stands of the RAPID MAGNETTING MACHINE CO., LTD. (C 421), and ELECTROMAGNETS, LTD. (C 605)

Foundry interest will also be evident on the stand of THOS. W. WARD, LTD., who are sole selling agents for the " Polford " range of foundry plant.

Tubes and Pipes.

Reference has already been made to some of the concerns who make metal tubes and pipes in the sections devoted to particular classes of materials. In many such cases, the production of tubes is only one of numerous activities, whereas in most of the firms covered by this section, tubes or pipes form the bulk of the output.

The TUBE INVESTMENTS LTD. stands, D 617/516 and D619/518, which are situated in the engineering section, will offer a cross-section display of the products manufactured by the precision steel tube and aluminium companies in the Group. A wide variety of seamless and welded tubes, in steel, stainless steel and aluminium alloys, will be shown—a clear indication being given of the wide range of industrial purposes to which they are put. The tubes will vary in size from one with an inner diameter of $23\frac{3}{8}$ in. to the " smallest tube in the world," with an inside diameter of 0·0005 in. Many non-circular and intricate composite bore tubes, used for scientific purposes, will be shown, in addition to some unusual examples of tube manipulation.

House building units in cold-rolled metal sections will be demonstrated, as also some large aluminium extrusions. The stand itself will incorporate a number of new constructional ideas in the use of the Group's tubular products, aluminium alloys and cold-rolled metal sections. The lighting of the stand introduces a new construction which will be seen for the first time.

STEWARTS & LLOYDS, LTD., with subsidiary and associated companies, are again exhibiting a wide range of their products. The Companys stands are located as follows: Engineering Group: D 511/408; Building Group: B 404; and Outdoor Exhibits: D Outdoor. The exhibits give an indication of the increasing use being made of steel tubes in a great variety of fields and illustrate the large contribution which S. & L. products are making to present day reconstruction and development.

In the Engineering Group, a reception stand (D.511/408) staffed by representatives of the Company is at the service of visitors for all enquiries relating to the exhibits and trade and technical matters generally. This stand features a tubular steel " Brook " bridge (in two 11 ft. 6 in. sections) manufactured by S. & L.'s subsidiary, Tubewrights Limited; examples of welded fittings for oil and gas list, coils and cold-rolled steel strip; and a series of large colour transparencies illustrating five stages of production from ore quarrying to the finished tube. A large aerial view of Corby, mounted on the roof, completes the exhibits on this stand.

The principal S. & L. stand (D Outdoor) is situated on either side of the North Entrance to Engineering Group D. At its western end a " Universal " Building of tubular steel construction has been divided into 10 bays in which a comprehensive range of the Company's products is on view. These include steel tubes and fittings for the conveyance of steam, gas, air, water, and sewage, etc.; tubular steel coils; examples of protective linings and sheathings; hot and cold-rolled steel strip; oil country tubular goods including welding fittings; coal mining equipment; foundry and basic pig irons; iron and steel castings; a 24 ft. ship's derrick, and steel and tubeworks by-products.

The various sections of this outdoor stand also house the exhibits of associated and subsidiary companies, including TUBEWRIGHTS, LTD., who make tubular steel fabricated equipment; ERNEST N. WRIGHT, LTD., specialists in blast-furnace steelwork, iron castings and structural engineering, and the LANCASHIRE & CORBY STEEL MANUFACTURING CO., LTD., makers of cold-rolled steel strip.

WELLINGTON TUBE WORKS, LTD., are one of the largest manufacturers of gas list tubes and fittings in the

country, and specialise also in developing the utilisation of tubes far beyond the orthodox use for conveying gases and liquids. Showing on their Stand C 300 are a selection of tubes, tubulars and fittings, and a considerable range of products incorporating tubular construction, including spiral wound gilled tube, space heaters and flanged pipework for pressure purposes. Also exhibited on the stand are stampings for various purposes produced by one of their subsidiaries, MESSRS. JOB EDWARDS, LTD., and the examples shown demonstrate the wide range available.

AITON & CO., LTD., who specialise in complete pipework installations for power stations, industry and ships will be exhibiting, on Stand D 608, examples of pipework for the highest operating conditions encountered in modern power station practice. These will include a chrome molybdenum steel superheater outlet pipe having fixed and loose Corwel joints with a creased bend branch with full reinforcement at the connection to the main tube, and with butt-welded flange-to-tube joints; a forged carbon steel steam separator 36 in. bore $\times 2\frac{3}{4}$ in. thick with Corwel and butt-welded branch connections; and a 38 in. bore cast iron branched bend with duckfoot support for circulating water service. Other exhibits are as follows:—Scale model of P. & B. evaporator; an Aiton forged steel steam trap for 900° F., 900 lb./sq. in. conditions; sectioned Corwel joints, butt-welded joints and low pressure bellows expansion joints; corrugated bent pipe made from aluminium tube; and a stainless steel bellows expansion joint.

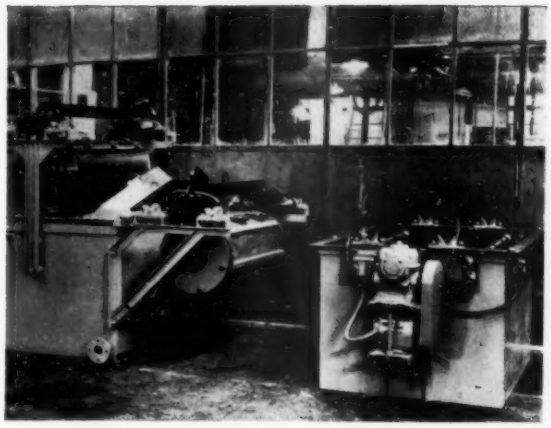
On Stand D 723, the BRITISH ERMETO CORPORATION, LTD., will show examples of their patent pipe couplings which are widely used at pressures from 500–15,000 lb./sq. in. They incorporate a case hardened Ermeto ring which cuts its own sealing flange as the locknut is tightened.

Wire

Wire in various shapes, sizes and materials plays an important part in many human activities, and nowhere more so than in mechanical and electrical engineering. Reference has already been made in the non-ferrous section to MESSRS. THOMAS BOLTON & SONS, LTD.

THE LONDON ELECTRIC WIRE CO & SMITHS, LTD., and its associate companies, FREDERICK SMITH & CO.,

Canning fully-automatic plating plant.



Efco-Udylite horizontal plating barrel and transfer unit.

The LIVERPOOL ELECTRIC CABLE CO., LTD., and VACTITE WIRE CO., LTD., will, on Stand C 619, display bare and insulated conductors for all electrical purposes including cotton, silk, paper, asbestos, glass, enamel and Lewmex insulated wires and strips, bare copper and copper alloy wires, strand, strip, sections and forgings. Cables for use in mines, quarries, ships, factories, railways, etc.; underground power cables and domestic flexibles; resistance wires and tapes; molybdenum wires, tapes and rods; and copper-clad, Vac-steel and pure nickel wires, etc., will also be shown. There will be a special feature of a wire drawing machine in operation illustrating the principles of the drawing of resistance wire.

On Stand D 607, JOHN RIGBY & SONS, LTD., will have a comprehensive display of many of the qualities of wire they manufacture in steel and mild steel in coils and lengths, and in bright-annealed, coppered, galvanized and tinned finish. The range of sizes covers from $\frac{1}{2}$ in. dia. to 44 s.w.g. (0·0032 in.) Prominence will be given to special sections in steel, mild steel, brass and nickel silver, especially emphasising precision drawn pinion rods, and also to crimped hardened and tempered brush wire, all of which have a special appeal to the dollar countries at the present time. A new "Manual for Wire Users" will also be ready for distribution at the Fair.

The non-ferrous side is catered for by the UNITED WIRE WORKS (BIRMINGHAM), LTD., who will be exhibiting on Stand D 218, round and shaped wire, rods and strip in brass, phosphor bronze, copper and nickel silver; and high-speed turning and screwing and hot stamping brass in rounds, squares and hexagons.

RICHARD JOHNSON & NEPHEW, LTD., on Stand B 417/320, will be exhibiting all types of ferrous and non-ferrous wires for industrial and agricultural uses, whilst the FIRTH CO., LTD., on Stand D 721, will be showing their mild and carbon steel wires which are mainly supplied to the bedding and seating industry, the wire-rope industry and for agricultural use. Other firms showing steel wire and wire products in coated and uncoated form are RYLANDS BROS., on Stand A 528, and on Stand A518, the WHITECROSS CO., LTD.

The emphasis of the display on Stand D 529 (WRIGHT'S ROPES, LTD., and the ROLLASON WIRE CO., LTD.) is laid on the very large steel and hemp ropes which are in daily production at Wright's works. Sections will be

Mark 27 metal spraying pistol.

Courtesy of Metallisation, Ltd.

shown of the rope stays supporting the Television mast at Sutton Coldfield, of winding ropes supplied to British and foreign mines, and of locked coil aerial carrying ropes. Included in the smaller exhibits is a sling incorporating Wright's new Patent Protective Device for splices in steel ropes.

The ROLLASON WIRE CO., LTD., are displaying some coils from their comprehensive range of alloy and high strain steel wires used by the motor, cycle, bedding and seating, and engineering industries.

Electroplating

With the acquisition of a somewhat larger Stand (D 652) than in previous years, FESCOL, LTD., are able this year to exhibit a wider variety of examples of electro-chemical deposition work carried out by them. Although the size of the stand still does not enable the Company to exhibit examples of the largest work undertaken by them, the opportunity has been taken to show some of the larger items treated, and to indicate the scope of the "Fescol" Process, as applied to many industries.

Examples exhibited cover "Fescolising" for the purpose of treatment of new parts for the prevention of corrosion and/or wear, and the salvage of worn or incorrectly machined components. Flanking one side of the stand are two examples of articles treated for the metal industry. One of these, a table roller approximately 10 ft. overall used to transport aluminium sheet during processing, and the other a leveller roll approximately 7 ft. overall used for the flattening of metal sheet. In both cases a deposit of chromium—in addition to the prevention of corrosion, improves the finished product. Examples of the largest type of work undertaken, represented by large illustrations, include a double reduction turbine gear shaft which had become worn by fretting corrosion.

Among the exhibits by the ELECTRO-CHEMICAL ENGINEERING CO., LTD., on Stand C 611, will be included an Efco-Udylite fully immersed horizontal plating barrel. Two types are made, one for acid and one for alkaline plating. With Efco-Udylite bright nickel, thicknesses of up to ·0005 in. can be deposited in 60 min. The barrel cylinders are made in three sizes, the capacity being up to 100 lb.

Also shown will be a storage and transfer unit for barrel plating. For production plating a complete line is installed, work being precleaned and pickled in a Monel cylinder which is rotated in these tanks and is transferred through the various stages. The storage and transfer unit is used for the transfer of work from the cleaning cylinder to the plating barrel. In this way the transfer is easily carried out and a supply of work is maintained ready for plating.

Automatic electro-plating equipment figures prominently in the equipment of the modern plating works as it does on Stand D 207/106 where W. CANNING & CO., LTD., will be exhibiting a number of items of equipment. An important feature of the fully automatic electro-plating plant shown comprises a central structural framework and conveyor carrying attachments engaging arms supporting the work racks; for the purpose of transferring the work from one tank to another through the various processes, a lifting carriage is mounted on the main framework.

In the automatic chrome barrel exhibited, the work is loaded by hopper feed, automatically carried through the barrel and discharged through a chute into a basket standing in a drag-out tank. Provision is made for transferring the barrel from the plating tank to an adjacent drag-out tank for swilling at the end of the shift.

For the polishing of a considerable range of articles, from lipstick cases to small circular articles up to 4 in. dia., a continuous automatic polishing machine will be shown. It consists of a central rotating table carrying a number of revolving chucks for holding the articles to be polished. Adjustable heads enable any polishing angle to be used.

Other exhibits include a Triangulated Centreless Banding Machine, No. 2718, for polishing rods and tube up to 6 in. dia.; dynamos; Canning-Westalite rectifiers; resistance boards; and finishing accessories.

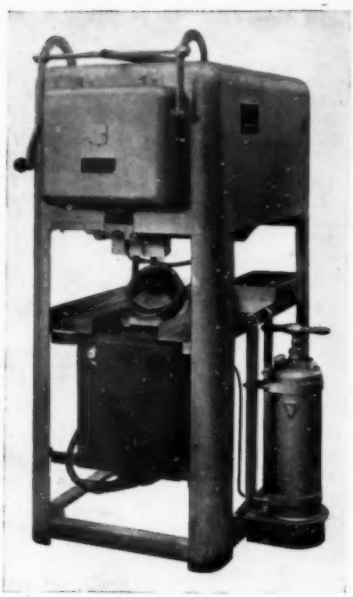
The main exhibit on the stand of COLEMAN & APPLEBY, LTD. (D 211) consists of a "Canda" semi-automatic plating unit complete with associated electrical gear. The plant briefly consists of a plating tank with heater compartment, heating coils, agitation coils, drain cocks, etc., together with superstructure carrying the cathode track assembly, cathode carriers and conveyor mechanism and drive. Articles to be plated are loaded and unloaded at one point and timing is controlled by varying the speed of the conveyor chain thus enabling the user to meet various specifications of thickness. The speed control of the conveyor, the voltage control of the rectifier, together with instruments, contactor gear, warning lights, etc., are housed in an attractive independently mounted control cubicle which may be sited to suit the operator. Other interesting exhibits include meter panels, resistance boards, plating chemicals, anodes and polishing compositions.

R. CRUICKSHANK, LTD. (Stand D 224), will be exhibiting the following new items of plating plant:—A specially designed, compact filter press, mounted on runners, for use with all types of plating solution; a new centreless polishing machine of special design; submerged barrel burnishing equipment; a new type immersed plating barrel for use with bright nickel solution; and a straight line automatic polishing machine. Other exhibits will include the standard polishing lathes, centrifuges, mops, polishing compositions, plating salts, etc.

Improved machines for electro-deposition, and materials for polishing and plating will be exhibited by HOKLYKEM, LTD. on Stand D 137.

Metal Spraying.

The use of metal spraying for coating and building up worn parts continues to progress, and on Stand D 326 METALLISATION, LTD., will be displaying a large variety of work metal-sprayed by users of their equipment. The Mark 16 pistol, which will spray all metals which can be drawn into wire form will be demonstrated, whilst the Mark 27 pistol will be exhibited for the first time. This is a toolpost pistol specially developed for building-up work and will spray high melting point metals using 4 mm. wires and maintaining the high quality deposit which has always been synonymous with "Metallisation" equipment. A fractional H.P. motor is used instead of a turbine. This shows a considerable saving in H.P. and by variable-speed governor control, fine adjustment can be maintained. In addition to normal equipment the pistol is fitted with a ball joint of a quick-acting type for fine adjustment in the lathe.



Wild-Barfield general purpose electric furnace—Type H.W.P.1.

Courtesy of Radio Heaters, Ltd.

"Radyne" induction generator.

The main feature of this year's exhibit of the SCHORI METALLISING PROCESS, LTD., on Stand D524, is a full scale shot blast and spraying unit to demonstrate the Schori method of flame spraying metals and plastics by the powder process. The plant displayed consists of a shot blast cabinet in which the surface of the article to be sprayed is cleaned and roughened by steel grit, and a spraying booth in which protective and decorative Schori coatings are applied. Surplus powder is recovered by means of a cyclone dust collector.

In addition to this unit Schori are displaying a variety of articles flame-sprayed with zinc, aluminium, tin, lead, copper, Polythene, Thiokol, etc., for protection against atmospheric corrosion, heat scale, ferrous contamination and chemical attack, or penetration of X-rays.

Galvanising, Sherardising and Calorising.

Of latest design, and on view at the Exhibition for the first time, a centre drive centrifugal machine for use with hot-dip galvanising will be shown by THOMPSON BROTHERS (BILSTON), LTD., on Stand D 635. This positive drive machine runs at 700 r.p.m., carries a load of 84 lb. and is push-button controlled. It reaches top speed in 4 secs., and brakes electrically in 3 secs. A cover interlock switch is incorporated so that it is impossible to operate the machine unless the cover is closed and locked. All working parts are protected from the spelter splash and can be easily removed without any part of the machine being dismantled. The machine is adaptable to tinning and oil separation.

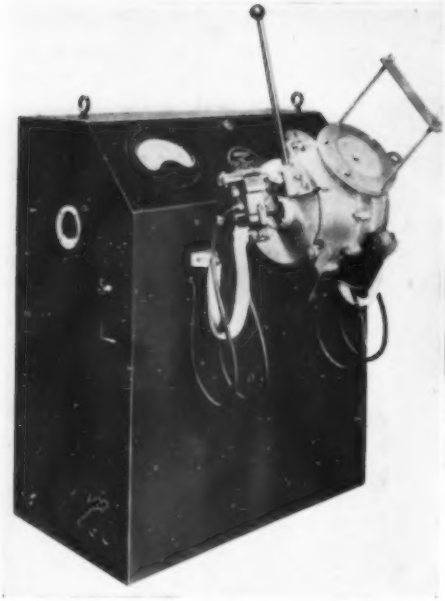
Also displayed on the stand will be a model of a galvanising plant for steel window frames comprising concrete and brick built sulphuric acid baths with steam heaters, hot and cold wash and flux baths, a drying stove and galvanising furnaces.

Examples of architectural ironwork rust-proofed by the sherardising process (coating with zinc by heating in zinc powder) will be displayed on Stand B 724 by the ZINC ALLOY RUST-PROOFING CO., LTD. The company does not manufacture architectural ironwork but specialises in carrying out sherardising for the actual makers of such items as steel casements, metal trim, electrical conduit, screws, nails, etc. The stand forms a Technical Information Bureau where visitors will be able to obtain full particulars of the process, its cost, and details of the uses to which it can be put in the various trades.

A similar process, in which aluminium powder is used instead of zinc, is calorising. The virtue of this treatment is the high degree of heat resistance conferred on steel parts thereby and on Stand 407/306, THE CALORISING CORPORATION OF GREAT BRITAIN, will be exhibiting calorised solid pressed steel heat treatment containers for cyanide, salt, lead, casehardening and annealing, together with pyrometer sheaths, air heater tubes, etc.

Furnaces and Refractories

Once again the BIRLEC Stand, D 509/406, will be "a stand in production." The 20 kW. shaker hearth furnace, which has undergone modifications to the quench tank arrangement, will be used for bright hardening small steel components. Although not new to the Birlec range the 10 kW 4 in. belt conveyor furnace will this year be used for copper brazing and bright annealing, the atmosphere being provided from a town's gas supply, by a Birlec Endothermic gas plant. Induction hardening will be demonstrated on a 25 kW Birlec H.F. induction hardening unit which will be used for the selective hardening of gear box sleeves. Two melting furnaces will be on view: a 6 kW H.F. spark gap set



Birlec Model " N " 17kVA. indirect arc furnace.

Courtesy of the Northern Aluminium Co., Ltd.

G.W.B. continuous " flash " annealing furnace for aluminium circles.

with 1 lb. crucible and a Model N.S. Birlec Detroit indirect arc furnace. The former will be melting cast iron for demonstration purposes. Other Birlec equipment for forge, foundry and factory will be represented by photographs.

On Stand C 321/220, WILD BARFIELD ELECTRIC FURNACES, LTD. will be showing a selection of their electric furnaces including a number of laboratory models. The H.W.P.1 horizontal general purpose furnace is suitable for temperatures up to 1,050° C. and is intermediate between the light duty furnace and the full scale production furnace. The V.W.P.1 vertical general purpose furnace can be operated at higher temperatures than the light duty furnaces and heat losses are reduced to a minimum by the specially designed split-type roll-off doors. Both these furnaces are equipped with Paragen atmosphere control. For toolroom work there will be shown a twin chamber high-speed steel furnace, the H.S.F 25, and a toolroom tempering furnace T.R.T. 1,010. Tempering, secondary hardening, ageing, annealing and nitriding are but a few of the processes available to the user of the forced air circulation furnace, one model of which, the 1612 C (with charge progress recorder) will be shown. For laboratory work the rectangular muffle furnace M.254 and the laboratory tube muffle M.94 will be on view. Developed specifically for industrial use, the Ferranti-Wild-Barfield induction heating equipments range from 2·5 kW. to 60 kW. The former of these will be shown, and other induction heating equipment on view includes an R.F. standard workhead, suitable for bench mounting, which may be used for hardening, brazing and experimental melting of various metals.

On the same stand, G.W.B. ELECTRIC FURNACES, LTD., will be showing a range of " Autolec " electrode boilers for steam raising. Of greater interest to heat treaters will be samples of " Eternite " case hardening compound and a K.L. Compound Controller by which the compound is taken straight from the boxes, graded, cleaned and stored ready for use without dust escaping into the air. Many recent furnace installations, some of them among the largest ever made in this country, will be represented in a display of photographs.

The ELECTRIC RESISTANCE FURNACE Company's chief exhibit, on Stand C 611, will be equipment for the bright hardening of small parts. The parts are loaded into the furnace at a point adjacent to the unloading section so that only one operator is required. For hardening the hearth is designed to drop the parts into the quench without the use of a scraper device. Atmosphere control is provided by an Efco Endothermic Generator which can also be used as a carrier gas in gas carburising and dry cyaniding.

Intended primarily for laboratory and research purposes, the 10 kW radio-frequency heat treatment and melting unit shown by the METROPOLITAN-VICKERS ELEC. CO., LTD., on Stand C 510 will melt 10 lb of steel in about 20 minutes. Adaption for brazing or heat treatment can easily be effected.

The 5 kW H.F. induction heater exhibited by the ENGLISH ELECTRIC CO., LTD., on Stand C 613/512, is a most versatile production tool. An adaptable work sink is integral with the heater cubicle and may be used for water or oil quenching. Vertical pillars are provided as guides for sliding brackets, holding coils, and the work itself and an automatic regulator maintains the filament and H.T. voltages constant to $\pm$ 1%.

RADIO HEATERS, LTD., on Stand C 219, are displaying one of their 10 kW C.80/A induction heaters complete with automatic handling gear for surface hardening $\frac{1}{2}$ in. dia. shafts over 3–4 in. lengths.

The extent to which gas is increasing in importance as an industrial fuel is illustrated by the 1948 figures of industrial sales which are about double the pre-war figures. As an example of the gas-fired equipment used in industry, there will be, on the GAS COUNCIL Stand D 639/538, a working model ($\frac{1}{4}$ scale) of a vertical slot furnace for tube and bar heating, made by the INCANDESCENT HEAT CO., LTD., and a high speed steel tool

hardening furnace made by MANCHESTER FURNACES, LTD. Other exhibits of metallurgical interest will include a display of burners of various types.

Once again the INCANDESCENT HEAT GROUP, Stand C 729/626, will show a selection of photographs and models mounted on conveyor belts. In this way a more comprehensive picture of the Group's activities will be obtained. Of the constituent companies, the INCANDESCENT HEAT CO., LTD., makes gas-fired furnaces for heat treatment, galvanizing, etc.; CONTROLLED HEAT AND AIR, LTD. manufacture core and mould drying stoves, spray booths, etc.; METAL PORCELAINS, LTD., specialise in vitreous enamelling plant and accessories. METALECTRIC FURNACES, LTD., are responsible for the electric furnace side, including resistance, direct arc, H.F. induction and dielectric core drying; whilst the SELAS GAS AND ENGINEERING CO., LTD., specialise in all types of gas burners and controls, etc. Among the new and interesting plants shown in the form of photographs and models will be a completely mechanised sheet mill incorporating a bar heating furnace, two pack heating furnaces and an annealing furnace, all of the walking beam type.

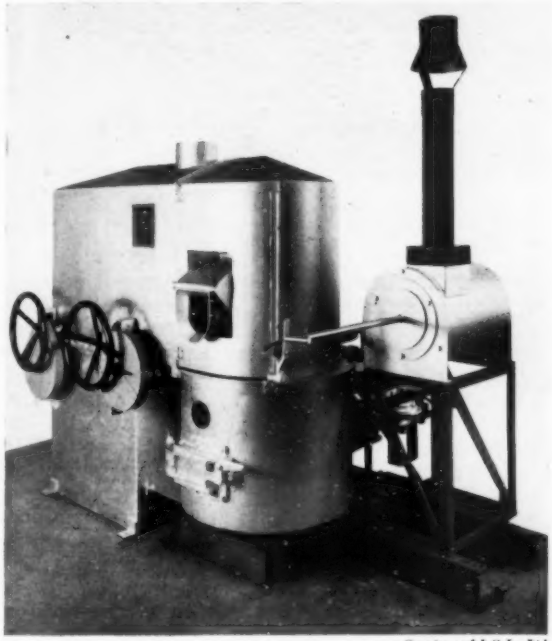
Gas and oil burners, fans and blowers will be featured on Stand D 505, occupied by WILLIAM ALLDAY & CO., LTD. For the first time they will be showing a new type of single deck hot brass stamping furnace with a special metallic lining which will not grow or distort in any way. Forced air is supplied by a fan and town's gas is the fuel. A patent blowpipe with automatic gas and air control will also be shown.

The display on the Stand of the GENERAL CHEMICALS DIVISION of IMPERIAL CHEMICAL INDUSTRIES, LTD., D 315/212, will illustrate the wide range of uses of "Cassel" heat-treatment salts and furnaces. A new neutral heat-treatment salt is shown for use in the range 720°–950° C. It is readily soluble in water and absolutely non-carburising. Also displayed will be a totally enclosed salt-bath furnace and quenching tank with hand-operated transfer mechanism. Designed for handling comparatively small batches of work it incorporates many of the advantages of the larger mechanised furnaces. The risk of salt splash is eliminated with this furnace which is suitable for working in the 700°–950° C. range. The plant will handle up to about 1 cwt. of work per hour.

Several trichlorethylene degreasing plants will be installed for normal working on the stand, including an electrically heated vapour plant with a motor-operated pumping attachment of new design, and a totally enclosed continuous plant for degreasing small parts of intricate shape.

For using solid fuel in metallurgical furnaces the Attritor Unit Pulveriser, made in capacities for 600–13,000 lb./hr., will be shown by ALFRED HERBERT, LTD., on Stand D 216/319, whilst on Stand D 535 the MIRLEES WATSON CO., LTD., will be exhibiting an improved model, Mark 2, of their coke-burning stoker. Experience of coke stokers in commercial service, combined with experimental work carried out in the Company's Research Department, has resulted in the development of this model.

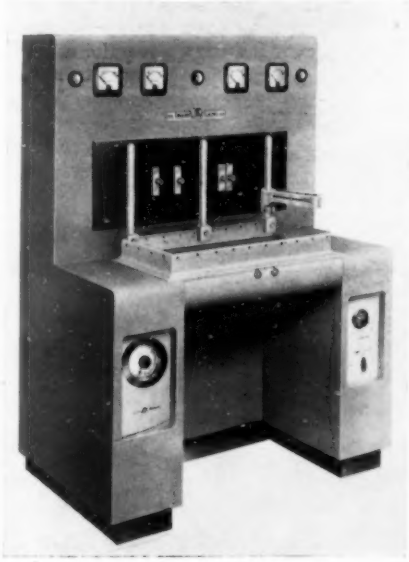
A wide range of refractories shown by JOHN G. STEIN & CO., LTD., on Stand D 313, will include silica bricks,



Courtesy of I.C.I., Ltd.

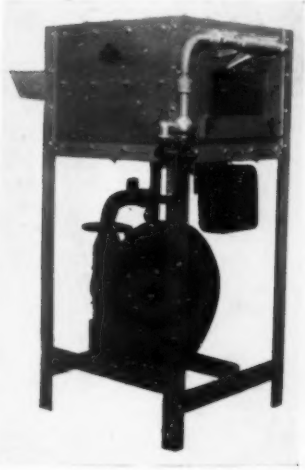
"Cassel" totally enclosed salt-bath furnace and quenching tank with hand-operated transfer mechanism.

English Electric 5 kW. induction heater.



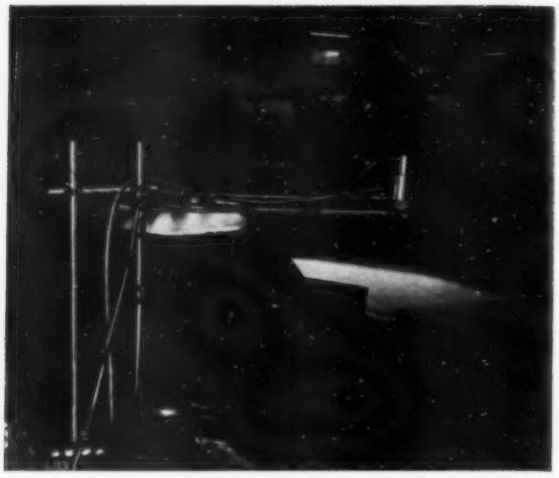
Single-deck hot brass stamping furnace.

Courtesy of Wm. Allday and Co., Ltd.



Courtesy of the Mirrlees Watson Co., Ltd.

Automatic coke stoker.



Courtesy of the Steel Company of Wales (Lysaghts), Ltd.

The Elliott high-speed radiation pyrometer in use on a pack mill.

firebricks, high aluminium bricks (sillimanite, mullite and corundum), basic bricks (magnesite, chrome-magnesite and chrome) both burned and unburned and also examples of various casting and ramming materials and cements. A special exhibit in the form of a full scale model of a section of an open-hearth furnace roof and uptake will show the use of chrome-magnesite bricks in open-hearth furnace construction. The use of Nettle brand firebrick in blast furnace hearth construction will also be featured.

Refractories for almost all purposes, made entirely from P.B. sillimanite, either by the usual bonding methods or the newer ethyl-silicate bonding process, will be shown by the P.B. SILLIMANITE CO., LTD., on Stand C 620. Furnace bricks, crucibles for laboratory use and precision casting, combustion and pyrometer tubes and refractory cements will be on view. Of particular interest in the metallurgical field are the "rammed linings" for gas-fired, oil-fired or Detroit arc-type furnaces. Lining "lives" of 26 months have been achieved and an average figure taken over industry as a whole would be about 15 months.

On the Stand of J. H. SANKEY & CO., LTD., B 405, Pyruma, Siluma and Aluma fire cements will be displayed along with Sankey's super acid-resisting cement; Vitrified Blue acid and alkali-resisting bricks; Aluma (highly aluminous) firebricks and B.M. Scotch firebricks. A display feature will be a section of an acid tank showing the application of the acid resisting cement and bricks.

The firebricks shown on D 305/204, the MORGAN CRUCIBLE COMPANY'S Stand, will include a selection of all grades for use in heat-treatment furnaces, ladles, etc., made by the associated DOUGLAS FIREBRICK CO., LTD. In addition, a range of high alumina grades of firebrick will be shown together with plumbago refractories.

Temperature Measurement and Control

This year marks the 150th Anniversary of the founding of the firm of ELLIOTT BROTHERS (LONDON), LTD., who, along with their associates the FISHER GOVERNOR CO., LTD., and B. & P. SWIFT, LTD., are exhibiting on Stand C 320. Elliott's made equipment for the experiments of Faraday, Davy and other pioneers who heralded the electrical age and to-day the range of products covers every type of electrical instrument for industrial process control. The standard electrical instruments exhibited are dealt with on p.408 of the Laboratory Methods Supplement to this issue, together with the "Elliottronic" potentiometer recorder. The "Elliottrol" Controller is a pneumatic device, operating on the force-balance principle, and capable of exercising three-term control. Its output is a variable pneumatic pressure suitable for positioning any of the usual types of diaphragm-operated process regulators, but the input may be either electrical or pneumatic, so long as it is proportional to the "deviation" of the controlled quantity. Another interesting exhibit will be the high-speed radiation pyrometer for steel rolling mills. The pyrometer head has a quartz lens which concentrates radiation from the hot steel onto a thermopile whose e.m.f. is amplified by a galvanometer photocell circuit, the output of which operates a direct writing pen recorder. The response is 98% in $\frac{3}{4}$ second. Other exhibits include a magnetic amplifier shown applied to temperature control, flowmeters and pressure recorders, thermal conductivity gas analysers, an optical pyrometer, and the Elliott-Shotter remote indication and control system.

On Stand C 700, ETHER, LTD., feature a number of recent control developments. Among these will be the Ether-Wheelco electronic controllers, "Capacitrol" for single position, and the "Multronic Capacitrol" for multi-position and proportional control. The "Throttltrol" with the "Multronic Capacitrol" provides proportional control to gas and oil-fired apparatus, whilst the Ether-Gordon "Xactline" anticipatory control device will eliminate "hunting" in a control variable due to thermal capacity. The "Flame-otrol" combustion safeguard will be exhibited with electrodes for use in conjunction with gas-fired apparatus and with a photocell for oil-fired apparatus. Various types of indicators, recorders and controllers, and surface and optical pyrometers will be shown. A new molten metal

pyrometer suitable for steel employs small precious metal couples and the temperature is indicated on a scale with a response time of less than two seconds. This is made possible by the use of a photocell amplifier which will be shown in conjunction with the "Foregemaster" radiation pyrometer for low temperatures and high speeds.

The range of instruments displayed on Stand C 727 (FOSTER INSTRUMENT CO., LTD.), covers the field from sub-zero to the highest temperatures. Amongst them will be multi-point temperature indicators, by which as many as 90 points may be measured at one central station; automatic temperature controllers including indicating types, programme controllers and a new electronic controller; a multi-point temperature recorder; and a Teloscale large scale illuminated indicator which can be read at a distance of 40 ft.

The Temperature measuring instruments shown by the CAMBRIDGE INSTRUMENT CO., LTD., on Stand D 758, will include mercury-in-steel and vapour pressure thermometers, a surface pyrometer of new design and thermometer regulators. A workshop potentiometer for checking thermo-electric pyrometer outfits and fitted with a self-contained potential source which enables an indicator to be deflected to any desired point on its scale will also be shown. Other exhibits of interest in furnace work are the CO_2 indicators and recorders.

The NEGRETTI & ZAMBRA quick-reading potentiometer shown on Stand D 237 is suitable for the rapid measurement of high temperatures, for checking the calibration of pyrometers and for research purposes. It incorporates a galvanometer with almost a zero period so that readings can be obtained in about two seconds.

A new system of temperature control having very wide applications both in industry and in the laboratory is being exhibited by P.A.M. Ltd., on Stand C 416. The instrument consists of a robust sensitive element in which the differential expansion of two metals operates a contact, which interrupts or passes a minute current, a special electronic amplifier making this current operate a 2½ kW relay. As the amount of movement required at the contact faces is very small (approximately 0·000002 in.) extremely sensitive and positive control results.

For the purposes of remote indication, the "Desynn" system shown by SMITHS INDUSTRIAL INSTRUMENTS, LTD., on Stand D 727 will be of interest. The transmitter and indicator are connected electrically and distant indication of pressure, displacement, temperature, fluid level, etc., is possible by this means.

On Stand D 643, PERL CONTROLS, LTD., will be showing a range of "Perl" automatic temperature and safety controls, including relay gas control valves for high/low or on/off operation; thermostats for ranges 0–800° C. and with 4–48 in. stem length; room temperature regulators; "Thermoperl" electromagnetic flame failure control valves; and an electro-magnetic gas valve.

Thermostats and motorised valves will also be featured on the Stand of the RHEOSTATIC CO., LTD. The former will include equipment for central heating, liquid tanks and space-heating control. (Stand C 500).

The range of instruments shown by SANGAMO-WESTON, LTD., on stand C 518, will be the same as that shown at Olympia and dealt with on pp. 407 and 408.

Machine Tools.

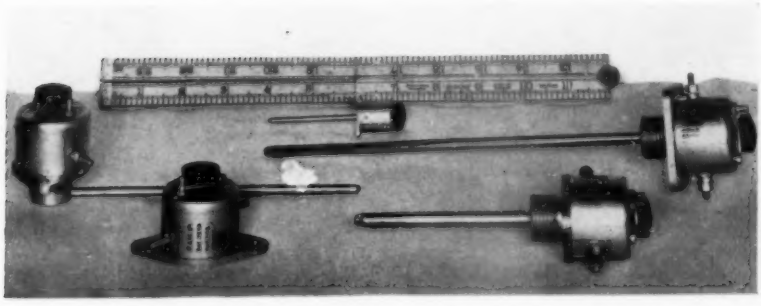
Although the machine tool trade in general is not represented at the fair, there are several items of equipment of interest to the metal working trade on show.

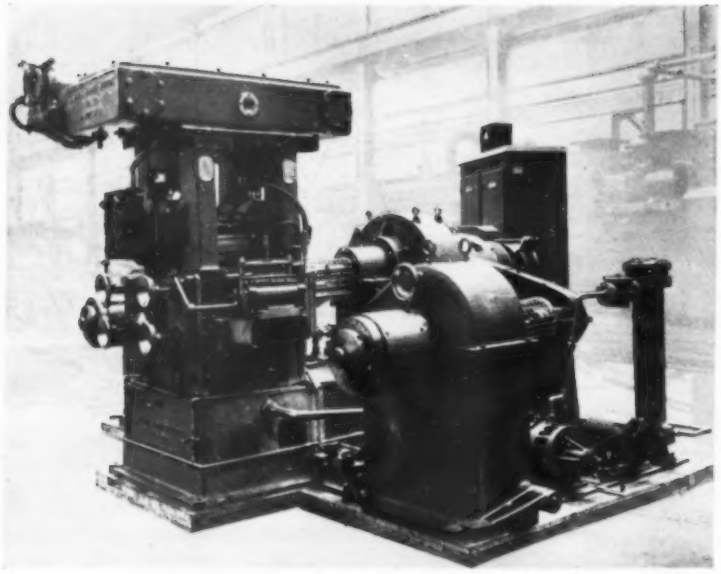
SIR JAMES FARMER NORTON & CO., LTD., specialists in plant for the wire-drawing and bar, tube and strip rolling trades will be exhibiting on Stand D 165, a 4-high 3in./8 in./8 in. reversing strip rolling mill designed for rolling steel of the saw and razor blade class up to 6 in. wide and from 0·020 in.–0·003 in. thick at 120 ft./min. Amongst the wire-drawing plant exhibits is the new type 4-block straight line re-active non-slip machine in which synchronous speed control of each block relative to the elongation of the wire is automatic, while any predetermined back tension may be imposed during the drawing operation. Other exhibits displayed include the slip type 19 die T.F.2. wire-drawing machine for drawing copper or steel at speeds up to 4,000 ft./min., with dies and drawing cones submerged in liquor, and a range of dies, mandrels, etc., made by Wire Drawing Dies (Manchester), Ltd.

A range of metal working presses, some in operation, will be shown by HORDERN, MASON & EDWARDS, LTD., on Stand D 500. These will include an H.M.E. Type 13 double action press in production on a triple action

Ether-Wheelco "Throttltrol" valve positioner.—Type E.W. 650.

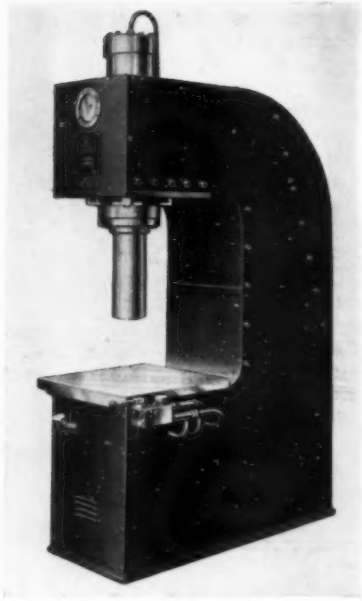
P.A.M. thermo-sensitive elements.





Courtesy of Sir James Farmer Norton & Co., Ltd.

4-high reversing strip rolling mill.



Finney 15/30 ton open-throat type arbor press.

operation in conjunction with specially designed tools and special air cushion equipment ; a re-designed 200 ton single action H.M.E. Type C28 press ; a re-designed 150 ton double crank single action H.M.E. Type D.C.P.5 press ; an H.M.E. Type L.70 open front single action press ; an entirely new design of end wheel drive press (30 tons), and, on the adjacent stand, a Type L.N.40 open front press of 40 tons capacity.

On Stand D 415, the presses exhibited by TAYLOR & CHALLEN, LTD., will include a B.3 ungeared press with double roll feed, tooled for producing washers from coil material ; a size 4½ toggle drawing press tooled for drawing 6 in. dia. × 6 in. deep aluminium cups ; and a double crank precision bending press.

Of the presses shown by FINNEY PRESSES, LTD., on Stand D 243, most are for plastic moulding but one, the 15-ton open throat type, downstroking press for arboring, assembly and straightening of light machine parts will be of interest. Hydraulic pumps and control valves will also be displayed.

Mills " Oilanlic " presses, made in a range of types and sizes from 6–500 tons capacity, are high production machines which can be equipped with a variety of attachments for straightening, bending, bush assembly, arboring, push broaching, riveting and similar operations. " Oilanlic " will be displayed on Stand D 335 (JOHN MILLS & CO (LLANIDLOES), LTD.

Developed by the parent Company in America, the 600 series of high production presses will be represented by the No. 675 press in E. W. BLISS (ENGLAND), LTD'S display on Stand D603. The No. 2 " Bliss " Stiles end wheel press, with a 12-ton capacity ; the No. 712A semi-automatic double seaming machine ; the No. 39 adjustable bed horn press ; and a number of bench power presses will also be shown.

Among the exhibits of TURNER BROTHERS (BIRMINGHAM), LTD., on Stand D 512 will be a range of T.B. power presses, including an inclinable press of six tons capacity and a new 15-ton geared press. Examples of pressed articles will also be displayed as will the Turner taper saw toothing machine.

FIELDING & PLATT, LTD., makers of all types of hydraulic presses and ancillary equipment, will be showing a new development on Stand D 132. This is the " Fielding " variable delivery high-speed radial oil pump for use with the modern self-contained hydraulic press. It is extremely suitable for the operation of presses where the closest possible control of operating speeds is required.

J. P. UDAL (Stand D 630) have specialised in the guarding of power and hydraulic presses in line with official and customers requirements for more than 20 years. Various types of guard will be shown under working conditions, including an adjustable hand-operated interlock guard which permits the use of small or large tools, without adjustment to the interlock mechanism.

Cambridge surface pyrometer.

In the "600" Group Pavilion, Outdoor Stand 1334, GEORGE COHEN SONS & CO., LTD., will be exhibiting the following metal working machinery: "Weybridge" gang slitting machine (medium gauge and light gauge); Coborn Wadley combined punching, shearing, cropping and notching machine (D.E.P.S.24); Coborn Wadley single ended shearing, cropping and notching machine (S.E.S.C.24); Coborn 20-ton open-front inclinable power press; Coborn 42 in. hand-operated wheeling machine; and 40- and 50-ton hydraulic presses.

A 50-ton portable hydraulic bending and straightening machine capable of handling joists up to 6 in. × 5 in. across the web and 10 in. × 6 in. across the flanges will be shown by SHEEPBRIDGE ENGINEERING, LTD., on Stand D 142, along with a Sheepbridge Kennedy gyratory crusher.

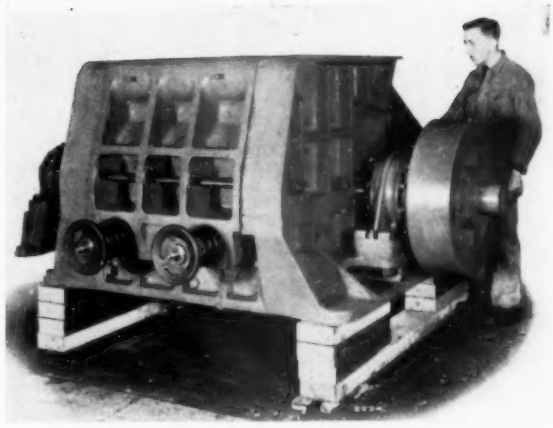
Eight new machines from the "Besco" range will be exhibited by F. J. EDWARDS, LTD., on Stand D 411. They include a production geared guillotine, a nibbler-shearing machine, a production treadle guillotine, a production bar cropper, an open-fronted vertical section rolling machine, a semi-automatic side seaming machine, a production universal rotary combination machine, and a production "Simple Flanger." A feature of this year's exhibit will be the production on the stand of lever lid and slip lid tin boxes.

Metal forming machines comprising the exhibit of A. W. MACNAMARA, LTD., on Stand D116 will include the "Macnamara" M.I.3 "C" chain making machine, the M.I.4 automatic wire and strip forming machine and the M.I.7 multi-slide wire and strip forming machine.

Along with the Sentinel Mark II unit press exhibited by the ROCKWELL MACHINE TOOL CO., LTD., will be a number of types of equipment manufactured under licence to the U.S. Tool Co., New Jersey, U.S.A. These will include a power driven stock straightener, a slide feed, a plain stock straightener, a combined stock oiler and wiper, a plain stock reel, an automatic stock reel, an automatic coil cradle and a Rockwell 6 in. scrap cutter. (Stand D157)

Courtesy of Elliott Bros. (London), Ltd.

"Elliottrol" trimode controller.

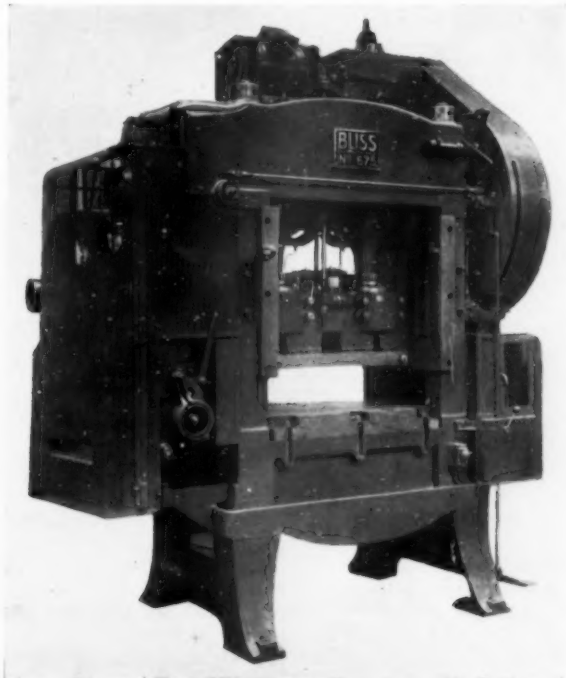


British Jeffrey-Diamond 42 in. × 36 in. flextooth crusher.

HEENAN & FROUDE, LTD., will include among their products displayed on Stand D226, an automatic strip forming machine, an automatic chain welding machine, an automatic high-speed wire straightening and cutting machine, an automatic fence staple machine, and a Heenan Dynamatic controlled-slip coupling.

Other metal working machinery will be shown by THOS. W. WARD, LTD., who are exhibiting on Stands D719 and 1360 Outdoor.

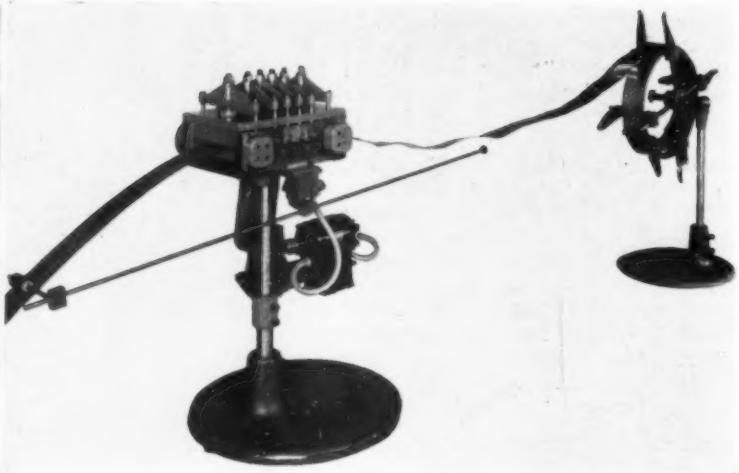
Metal cutting machines displayed by the MIDLAND SAW AND TOOL CO., LTD., on Stand B 228, comprise an overhead cut-off machine for aluminium sections, an automatic moving table bandsaw machine cutting



Bliss No. 675 high production press.

Courtesy of the Midland Saw and Tool Co., Ltd.

Bandsaw for cutting cylinder blocks.



Courtesy of the Rockwell Machine Tool Co., Ltd.

Power-driven strip stock straightener.

cylinder blocks for inspection purposes, a 36 in. Hyspeed friction sawing bandsaw machine for sheet metal, a new A.T.C. toolroom bandsaw machine with canting body, and the Major toolroom bandsaw machine.

There is a machine in the BRITISH JEFFREY-DIAMOND range of breaking, crushing, pulverising and grinding machines for friable materials to suit product requirements from 8 in. cube down to minus 300 mesh in capacities from a few hundredweights to hundreds of tons per hour. A feature common to all is their ability to produce the required product in one passage through the machine. A selection of these machines will be on view on Stand D 526.

Small Tools and Tool Steels

Stand D 627 is of novel design consisting of a circular office round which the name style FIRTH BROWN TOOLS, LTD. will slowly revolve. Mounted on the transparent office windows—seven in all—will be a representative range of Firth Brown Tools including lathe tools, milling cutters, saws, dies, shear blades, etc., and a typical selection of tools boxed in their colourful and modern packs for safety and storage. Of particular interest on the two " L " shaped counters at the front of the stand, which will feature tools and give typical performances and examples of material cut, will be small diameter reinforced shank drills down to 0·004 in. dia.

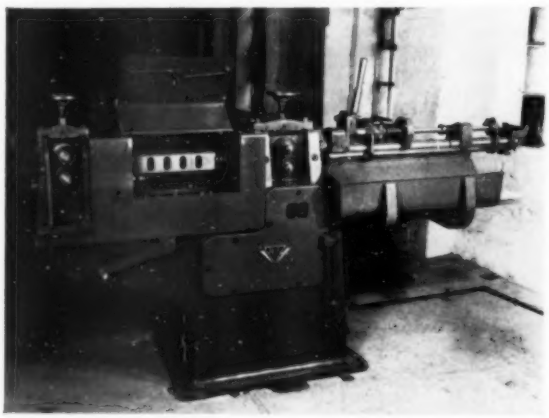
Sigma inspection machines, including the Sigma Multi-Dimension Inspection machine by which 28 dimensions may be checked simultaneously; and a number of Hilger projectors will be featured on ALFRED HERBERTS Stand, D 216/319, along with the Hilger photo-electric Strainviewer. A wide range of Herbert small tools will also be displayed, including cutters, Ardoloy tipped tools, and the Microbore adjustable precision boring unit.

An outstanding exhibit on Stand D 341, JAMES NEILL & Co. (SHEFFIELD), LTD., will be the improved Eclipse Permanent Magnet Chuck. A new design and the use of " Alcomax " magnets result in a height reduction and a higher magnetic efficiency, which enables uneven surfaces to be held more easily. Other exhibits include a range of magnetic chucks, hacksaw blades and frames, tool bits, cutting-off tools, vices, vee blocks and automatic centre punches.

On Stand D 402, DELORO STELLITE, LTD., will be demonstrating the deposition of Stellite by oxyacetylene and arc welding. Also displayed will be Stellite precision castings, numerous types of cutting tools and Stellite drills developed for drilling hardened steels and removing broken taps.

In the tool steel section of the EDGAR ALLEN Stand, D 534, the visitor will find displayed the latest in butt welded high speed steel tools, precision ground form tools, tungsten carbide tipped tools and Athyweld deposit-welded wood-working machine knives, knurling tools hot shear blades, etc. There will be a representative display of dies made from different types of die steels and also an exhibit of permanent magnets for numerous industries.

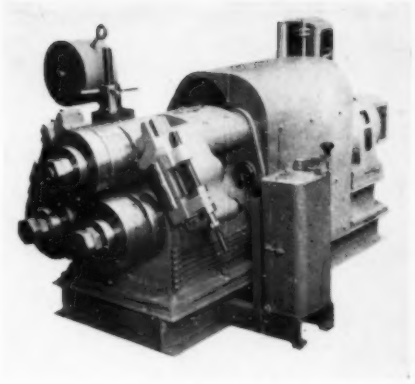
A complete display of WOLF electric tools will be exhibited on Stand C 603, comprising electric portable



Courtesy of Herman and Froude, Ltd.

Automatic high-speed wire straightening and cutting machine.

drills, screwdrivers, grinders, polishers, sanders, blowers, chisel mortisers, hammer kits, a range of engine reconditioning equipment including valve seat grinders and valve and engine servicing kits—valve refacers, "Mobilectric" engine workshop and the range of "Wolf" electric Solderguns. New introductions to the B.I.F. are the latest 4-in. hand grinder (Model GQ4) and the 7-in. horizontal sander (HS7).



Courtesy of F. J. Edwards, Ltd.

Model 1B "Besco" open-fronted vertical section rolling machine.

A display of die sets and other tools made in the various qualities of "Motor" brand tool steels will be seen on the stand of RICHD. W. CARR & CO., LTD., D 232. "Motor" brand tool steels shown include those for the hot working, die casting, cold working and machining of metals. A range of finished small tools will also be on view.

Specimen tools made from the Company's tool steels will be displayed by TURTON BROTHERS & MATTHEWS, LTD., on Stand D 413, together with a range of cutters, shear blades, heavy coil springs, and magnets including brazed mild steel-Alnico and-Alcomax units.

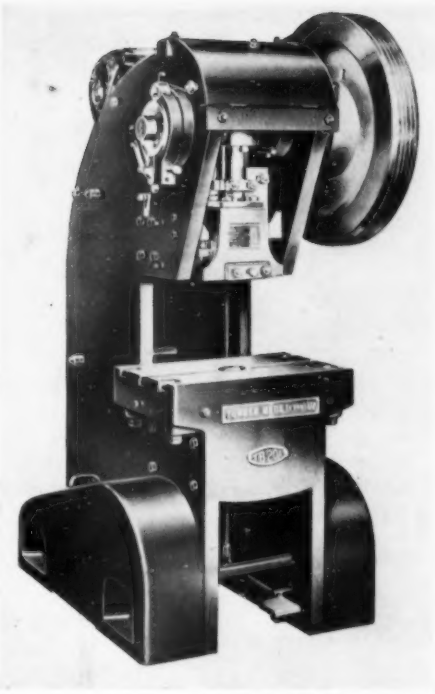
Other firms exhibiting tools include LENCHS (BIRMINGHAM), LTD., who will show "Oakaloy" cemented carbide tools and wire drawing dies on Stand D 113, together with specialised tooling; JOHN GARRINGTON & SONS, LTD. (D 206), makers of the "Flying Bird" series of hand tools; THOMAS CHATWIN & CO., LTD., and JOHN BROOKS (LYE), LTD. on the BROCKHOUSE Stand, D 405/304; and GEORGE H. ALEXANDER MACHINERY, LTD. (D 632).

The DAVID BROWN TOOL CO., will exhibit gear cutting and measuring tools, floating reamers, and jigs and fixtures on Stand D 343; DUREX ABRASIVES, LTD., a range of coated abrasives and the Hamilton Surface Grinder developed for simultaneously wet grinding both sides of metal sheet and strip; and ELECTROMAGNETS, LTD., and the RAPID MAGNETTING MACHINE CO., LTD., magnetic chucks.

Laboratory Equipment.

As usual the weighing devices to be seen on the W. & T. AVERY, LTD. Stand, D 523/420 will be many and varied. Apart from these, a number of mechanical testing machines on show will be typical examples from the Avery range. An example from the tensile and compression range on show is the 7102 CCH 50-ton tensile machine, certified accurate to $\pm \frac{1}{2}\%$ for loads over 25% of each chart capacity. There are four capacity ranges, one of which is selected by turning a handwheel.

Shown for the first time at the Fair, although it has been in production for several years, will be the Model T 42B dial indicating universal testing machine, to be seen on the SAML. DENISON & SON, LTD., Stand D 125. This is a four range machine, of 30 or 50 ton capacity, with a single circular scale, but only the figures appropriate to the range in use are visible to the operator. Although hydraulically loaded, the load is measured by means of a highly sensitive knife-edged lever system. Other exhibits include the T.42 dial indicating 12,500 lb. tensile machine, the 150-ton T.1A hand-operated hydraulic compression testing machine, and a number of weighing machines.



Courtesy of Turner Brothers (Birmingham), Ltd.

T.B. 20A power press of 20 tons capacity.

Hardness testing machines shown will include the fixed and variable load Firth Hardometer on Stand D 627 (FIRTH BROWN TOOLS, LTD.) and a new model of the Rockwell hardness tester on the GEORGE H. ALEXANDER MACHINERY, LTD., stand, D 632.

For general laboratory furnace work, melting, assaying and sintering, a range of crucibles, muffles, tubes, dishes and boats made from normal refractory materials, Morganite plumbago, and the recrystallised pure oxides—alumina, magnesia, zirconia and thoria—will be displayed by the MORGAN CRUCIBLE CO., LTD. on Stand D 305/204.

Miscellaneous

The products of MINWORTH METALS, LTD. who are exhibiting on Stand D 253 include a number of ferro-alloys — ferro - tungsten, ferro - molybdenum, ferro-vanadium, ferro-titanium—molybdenum oxide, and calcium molybdate, pure manganese metal for the manufacture of manganese hardeners, and high-purity chromium metal.

SINTERED PRODUCTS, LTD., who are exhibiting on Stand D 142 will have on show, oil-retaining bushings in sintered bronze and sintered iron; bushings in various alloys; sintered components such as pistons and automobile parts; and sintered metal filter material (Porosint); all made by powder metallurgical methods.

Three iron powders will be shown by GEORGE COHEN & SONS, LTD. in the "600" Group Pavilion (Stand 1334 Outdoor): "Sintrex" metallurgical iron powder,

Denison Model T42B dial-indicating universal testing machine.

"Sintrex" electrolytic iron powder and "Sintrex" grey iron powder.

In addition to pyrometers, the FOSTER INSTRUMENT CO., LTD. will be showing a number of new "Introscopes" on Stand C 727. Used for internal visual inspection work, models available range from 5 mm. diameter with an operative length of 50 cm. to 34 mm. diameter with a 610 cm. (20 ft.) operative length.

The industrial use of magnetic devices is increasing rapidly for such purposes as lifting steel plates, bars, scrap, etc.; sand cleaning by separating tramp iron; concentrating magnetic materials, such as ore; holding steel and iron components for grinding and machining; transmission clutches, etc. Each year sees fresh developments in this field and those interested should visit Stands C 421 and C 605 where can be seen the exhibits of the RAPID MAGNETTING MACHINE CO., LTD. and ELECTROMAGNETS, LTD., respectively.

For rust removal and rust prevention treatment prior to plating or painting, Stand B 221 will be displaying the latest preparations of JENOLITE, LTD. used in many industries for improving the quality and permanence of finishes on steel and iron. Centre of the Jenolite exhibit will be a scaled model of a modern metal pretreatment plant comprising four tanks—a degreaser, two Jenolising tanks, and a hot rinse tank. Also exhibited will be Jenolite paint stripper (P.S.5) and Jenolite A.K.S. aluminium keying solution for the pretreatment of aluminium prior to painting.

A range of anti-dermatitis barrier preparations will form the principal exhibit of ROZALEX, LTD. on Stand D 706. Almost twenty-five years research on combating this enemy of production and morale has led to a stage where it is possible to provide a preparation that will guard against almost all the known irritants. The Rex Dispenser, for providing an economical and uncontaminated supply to every worker will also be shown.

Amongst a varied display of electrical equipment to be found on the BRITISH THOMPSON-HOUSTON Stand, C 511/410, will be found typical "Pyrobar" heater units for a wide variety of applications. Consisting of a resistance spiral solidly embedded in magnesium oxide and protected from mechanical damage by an outer sheathing, they are quite suitable for direct immersion in liquids and soft metals where chemical action does not affect the protective sheathing material.

Rozalex "Rex" dispenser.

METAL PROCESSES, LTD., who are exhibiting on Stand D 229, specialise in industrial finishes for colouring and protecting metal articles and in methods for rust prevention, rust removal and degreasing. They are also manufacturers of chemical immersion finishes and equipment for such processes. Examples of these products will be displayed on the stand along with a range of welded tanks and fabrications.

On Stand D 532, CROFTS (ENGINEERS), LTD. are showing a comprehensive display of power transmission equipment among which is included a wide variety of their range of standard products. Working exhibits include: variable-speed gears and pulleys; stoker drive gear-box; gear units; and "Airflex" disc and rim clutches. Other exhibits of special interest will be the "Ritespeed" geared motor; "Radiation" worm-gear units and various types of split-taper adaptor pulleys.

Visitors interested in planning new factories or improving existing ones will be interested in the exhibits on Stand B 615/512, where HILLS (WEST BROMWICH), LTD. will be showing their permanent steel-framed school construction; structural steel; lead and aluminium roof glazing; metal windows and doors; and similar products. Of special interest for metal-working shops will be the ventilating shutters which provide what is virtually a moveable roof. Available for manual or electrical operation, they can be completely closed or partially opened to any angle, up to 65°, to suit prevailing conditions.

A range of cutting oils, lubricating oils, rust preventives and heat-treatment oils will be shown by FLETCHER MILLER, LTD. on Stand D 240. The last-named will be of special interest to readers, including as they do quenching and tempering oils. "Almarine" quenching oils combine low coking tendencies with freedom from light volatile fractions and low viscosity. There are two grades, one for general use and the other for use with cyanide salt baths. Within the range 100°–300° C. tempering in "Almarine" tempering oils is preferable to colour or salt bath tempering. Flash and ignition points are high and carbon formation is retarded. Other heat-treatment exhibits include Hard-N-Deep box carburising compounds made in all-charcoal or blended mixtures.

Continued on page 400

Fatigue Properties of Four Cast Aluminium Alloys at Elevated Temperatures[1]

By J. McKeown, D.Sc.[2], D. E. Dineen, B.Sc.[3], and L. H. Back, B.Sc.[4]

Communication from the British Non-ferrous Metals Research Association.

Results are given of a series of fatigue tests carried out to determine the relationships between endurance limit and temperature for four cast aluminium alloys. The work forms part of a study of the mechanical properties of light alloys at elevated temperatures.

Introduction

THE fatigue tests recorded in this paper were made as part of a wider investigation of the mechanical properties of light alloys at elevated temperatures, carried out for the Principal Director of Scientific Research (Aircraft), Ministry of Supply.

The tests were made on the B.N.F. Rotating Load Fatigue Testing Machines, described in *Metallurgia*, September 1948, **38**, 247–254. In these machines the cantilever specimen is subjected to a rotating bending moment, any element at the most highly stressed section of the specimen being stressed between equal and opposite stresses in each revolution of the rotating load.

Since the force causing the bending moment is that due to the centrifugal force of an out-of-balance mass and is consequently proportional to the square of the speed, close control of speed is essential. The machines are at present driven by governor-controlled D.C. motors in which the speed control is better than ±1%. At the time the tests on modified aluminium–12%silicon alloy (B.S. 2L33) and on aluminium-silicon-copper alloy (D.T.D. 424) were carried out, however, the machines were driven by synchronous motors so that the speed was directly proportional to the frequency of the electrical supply. Thus the effect of variations in frequency of the electrical supply was to produce a greater proportionate variation in the stress. In view of this, it is considered that some of the scatter of results obtained with these two materials may be due to variations in stress from the nominal value during the progress of each test. It is considered, however, that the tests give a clear indication of the effect of testing temperature on the endurance limit.

Some scatter is inevitable in the fatigue results obtained from cast materials and the degree of reproducibility of material and of testing conditions can be judged from the scatter shown in the plotted results in Figs. 1–4.

Materials

The materials tested were:

(*a*) Cast modified aluminium—12%silicon alloy to B.S. 2L33.

(*b*) Cast aluminium-silicon-copper alloy to D.T.D. 424.

(*c*) Die-cast Y-Alloy.

(*d*) Die-cast aluminium-silicon-nickel-copper-iron alloy, Lo-Ex.

Casting Conditions

(*a*) *B.S. 2L33.*

Standard D.T.D. bars were cast in sand moulds from four melts, each made in a gas-fired injector furnace and modified by covering with 2NaF/1NaCl flux at 780°C. leaving for 10–15 minutes before pouring at 700° C.

(*b*) *D.T.D. 424*

Standard D.T.D. bars were cast in sand moulds from two melts at 720°C., each made in a gas-fired injector furnace and degassed with 2% by weight of 2NaCl/1NaF flux. The first melt was of ingot supplied by a member company, the second of clean scrap from the first melt together with new ingot.

(*c*) and (*d*) *Y-alloy and Lo-Ex.*

The materials were supplied by a member company as die cast bars 7 in. long by 1 in. diameter, prepared in the following manner. Both materials were melted under "Coverall", degassed with "Foundry Services Degassing Compound" and horizontally die cast from single melts. The bars of both materials were poured between 710° and 690° C. in the order indicated by their numbers.

The analyses of the materials are given in Table I.

TABLE I.—COMPOSITION OF MATERIALS TESTED.

Material	Melt	Cu	Fe	Si	Ni	Mg	Mn	Ti	Zn	Pb	Sn
B.S. 2L33	1	0·06	0·30	12·5	—	—	0·025	0·01	—	—	—
	2	0·04	0·28	12·0	—	—	0·008	0·008	—	—	—
	3	0·06	0·30	12·3	—	—	0·03	0·002	—	—	—
	4	0·06	0·40	12·6	—	—	0·04	0·005	—	—	—
D.T.D. 424	1	2·94	0·76	4·52	0·32	0·03[a]	0·44	0·12	—	—	—
	2	2·70	0·92	4·65	0·30	0·02[a]	0·42	0·13	—	—	—
Y-Alloy	—	4·44	0·29	0·15	2·11	1·63	0·02[a]	0·04[a]	0·04[a]	n.d.	n.d.
Lo-Ex	—	0·89	0·46	10·62	2·59	0·77	0·01[a]	0·02[a]	0·06[a]	n.d.[a]	n.d.[a]

[a]—Determined spectrographically.
n.d.—Not detected.
Note:—The Y-alloy is seen to conform to B.S. 704 and the Lo-Ex to British Patent Specification 334,656.

Heat Treatments

No heat treatment was given to the bars of B.S. 2L33 and D.T.D.424.

The die cast bars of Y-alloy and Lo-Ex were supplied in the as-heat-treated conditions. The heat treatment had consisted of solution treatment at 510° C. for six hours, cooling rapidly to room temperature and ageing at 175° C. for 10 to 12 hours.

1 B.N.F.M.R.A. Report R.R.A. 875P. The work described in this paper was made available to members of the B.N.F.M.R.A. in a series of confidential research reports issued in 1947 and 1949.
2 Head of Mechanical Testing Section, British Non-Ferrous Metals Research Association.
3 Formerly Research Assistant, British Non-Ferrous Metals Research Association.
4 Investigator, British Non-Ferrous Metals Research Association.

Tensile Properties

Ordinary tensile tests in accordance with B.S. 1094/1943 were made on 0·564 in. diameter specimens of B.S. 2L33 and of D.T.D. 424 at 100°, 200° and 300°C. with the results given in Table II.

TABLE II.—ORDINARY TENSILE PROPERTIES OF THE MATERIALS.

Material	Temperature of Test °C.	0·1% Proof stress tons/in²	U.T.S. tons/in²	Elongn. % on $4\sqrt{A}$
B.S. 2L33	100	3·4	9·2	12
	200	2·8	6·2	13
	300	<1·0	4·2	12
D.T.D. 424	20	6·0	10·6	3
	100	4·9	10·1	2
	200	5·5	9·5	3
	300	4·4	6·2	4
Y-Alloy	20	—	22·8—24·4	0
Lo-Ex	20	—	21·4—23·2	0

The room temperature tensile properties of the Y-Alloy and Lo-Ex had been determined by the supplier and are also given in Table II.

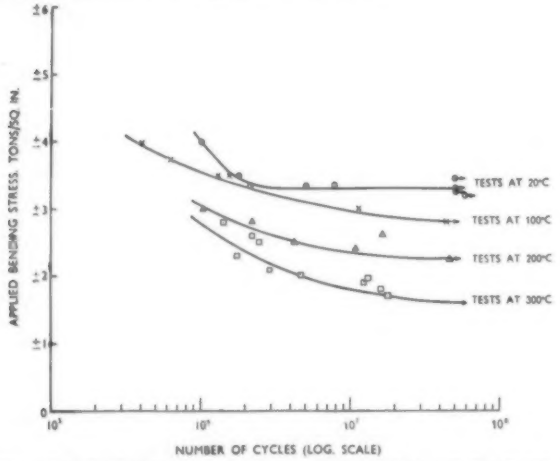


Fig. 1.—Endurance curves for material to B.S. 2L33.

Fatigue Specimens and Testing Technique

The tests were made at 3,000 r.p.m. on specimens of overall length 6·8 in. and diameter 0·550 in. at the section subjected to maximum bending stress. The specimens were machined so that the larger gripped end was from the upper portion of the D.T.D. bar and the position of maximum bending stress occurred at a distance of approximately 3·75 in. from the smaller (lower) end.

The maximum stress region of each specimen was polished longitudinally using 500 grade emery paper. The specimen was heated in a small wire-wound electric furnace controlled by a Sunvic energy regulator which, since the tests were carried out in a constant temperature room, gave a reasonably satisfactory control of the specimen temperature even with the small furnace used. The specimen temperature was measured at the point of maximum bending stress by means of a thermocouple with flattened weld-bead strapped by means of asbestos tape in metallic contact with the specimen. The heating-up period occupied about one hour and was followed by a 24-hours "soak" at temperature before the commencement of test. The temperature during the testing period was in all cases constant to within better than ±1·5% of the nominal value.

Results of the Fatigue Tests

In fitting the endurance curves to the experimental points in Figs. 1–4 a conservative approach has been adopted throughout, since it is recognised that in the majority of cases a much larger number of tests would be required to cover the possibility of any slight unsoundness in a casting coinciding with the region of maximum stress in the test sample.

B.S. 2L33. The results obtained are plotted in Fig. 1 and from the curves endurance limits corresponding to 50×10^6 cycles of stress have been estimated as follows:

Temperature of Test °C.	Endurance Limit (50×10^6 cycles) tons/in.²	Ratio of Endurance Limit to that at 20° C.	Ratio of Endurance Limit to U.T.S. at same temperature
20	±3·3	1·0	0·31
100	±2·8	0·85	0·30
200	±2·25	0·68	0·36
300	±1·6	0·48	0·39

It may be noted that the ratio of endurance limit to U.T.S. is not constant over the range of temperature investigated but increases with temperature.

D.T.D. 424. The results obtained on this alloy are plotted in Fig. 2 and the estimated endurance limits are as follows:

Temperature of Test °C.	Endurance Limit (50×10^6 cycles) tons/in²	Ratio of Endurance Limit to that at 20°C.	Ratio of Endurance Limit to U.T.S. at same temperature
20	±4·0	1·0	0·38
100	±3·55	0·89	0·35
200	±3·9	0·98	0·41
300	±2·7	0·68	0·45

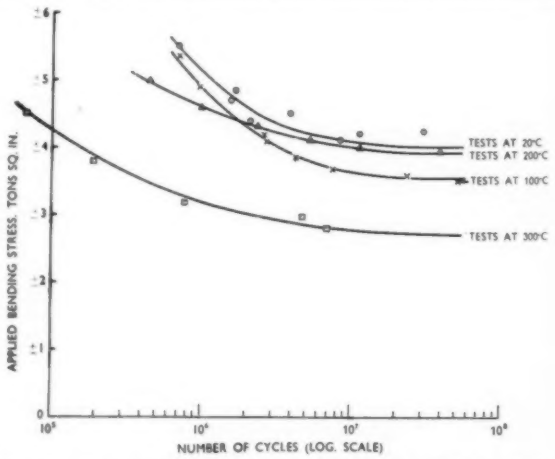


Fig. 2.—Endurance curves for material to D.T.D. 424.

A feature of the results on this alloy is the higher endurance limit obtained at 200° C. compared with 100° C. It was thought that this result might be due to precipitation hardening occurring at the test temperature, particularly during the soaking period of 24 hours prior to commencement of the test. To confirm this possibility samples of the D.T.D. sand cast bars were held at 100°, 200° and 300° C. for times of 24 hours and 12 days (corresponding to the time required for 50×10^6 cycles

of stress in the fatigue test), room temperature hardness tests being made before and after these treatments. The results are given in the following table.

EFFECT OF SOAKING TEMPERATURE ON HARDNESS. HARDNESS VALUES GIVEN ARE MEAN OF FIVE DETERMINATIONS IN EACH CASE

	Temperature °C.	Initial Hardness V.P.N.	Hardness after soaking–V.P.N.	
			24 hours	12 days
Melt 1	20	82·0	—	—
	100	82·2	78·1	83·8
	200	82·8	89·6	85·4
	300	81·9	68·6	64·9
Melt 2	20	79·6	—	—
	100	80·3	74·6	79·5
	200	79·3	80·0	81·0
	300	81·7	64·0	59·7

It appears probable from these results that the higher endurance limit obtained at 200° C. compared with 100° C. is caused by the heat treatment occurring during the fatigue test.

Y-Alloy. The results for this alloy are shown in Fig. 3 and the following endurance limits were estimated :

Temperature of Test °C.	Endurance Limit (50×10^6 cycles) tons/in²	Ratio of Endurance Limit to that at 20°C.	Ratio of Endurance Limit to U.T.S. at same temperature
20	±6·5	1·0	0·28
100	±6·8	1·05	—
200	±7·0	1·08	—
300	±5·3	0·82	—

Lo-Ex. The results for this alloy are given in Fig. 4, the estimated endurance limits being :

Temperature of Test °C.	Endurance Limit (50×10^6 cycles) tons/in²	Ration of Endurance Limit to that at 20°C.	Ratio of Endurance Limit to U.T.S. at same temperature
20	±6·3	1·0	0·28
100	±6·9	1·10	—
200	±6·3	1·0	—
300	±3·5	0·56	—

It would appear that the precipitation treatment of 10–12 hours at 175° C. had not stabilised these latter two materials at 100° C., as shown by the increase in the endurance limit at 100° C. compared with that at 20° C. Further precipitation must have been proceeding during the time of testing at 100° C. although no evidence could be obtained of this from metallographic examinations.

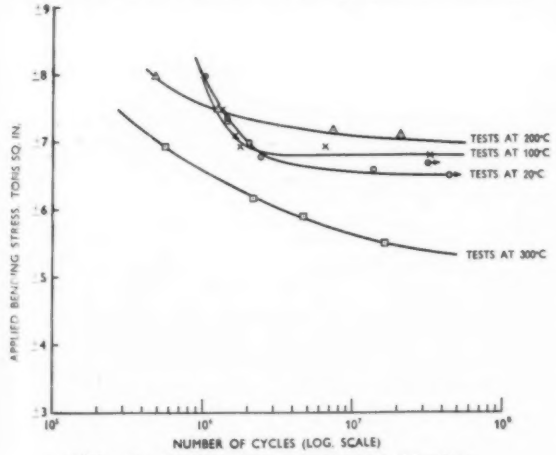


Fig. 3.—Endurance curves for Y-alloy.

Also, in the case of the Y-alloy, additional precipitation was possibly produced at 200° C. although again this could not be detected metallographically.

It is not possible from the present series of tests to be certain that the increased endurance limits obtained at 100° C. in Lo-Ex and at both 100° and 200° C. in Y-alloy would be retained for much longer times at these temperatures. It may be noted that the time for 50 million cycles of stress plus the initial soaking time is approximately 300 hours and it is possible that the endurance limit would start to fall again at still longer times. Insufficient material was available to test the effect of soaking for, say, 2,000 hours at 100° and 200° C. on the endurance limit at these temperatures.

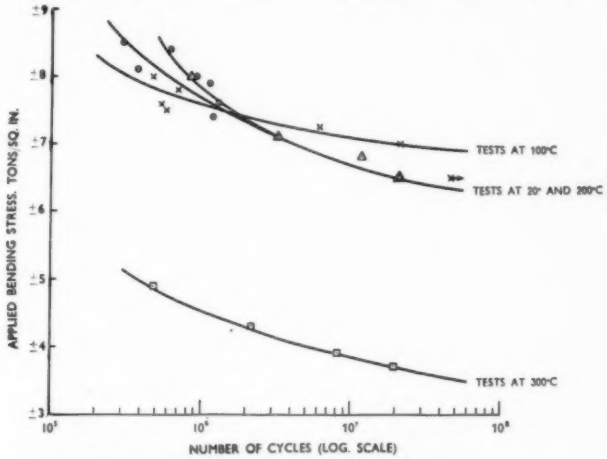


Fig. 4.—Endurance curves for Lo-Ex.

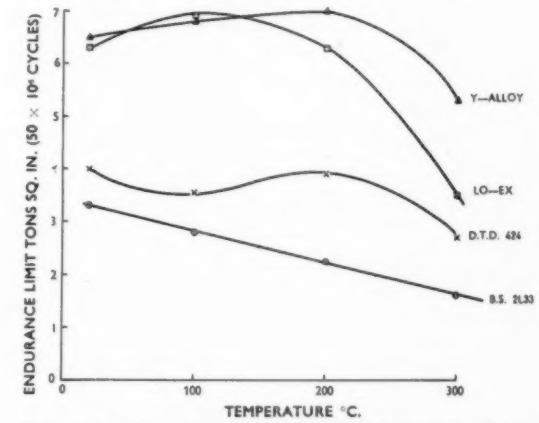


Fig. 5.—Endurance limit-temperature relationships.

Conclusions

The relationships between endurance limit and temperature for the four alloys tested in the cast condition are given by the curves in Fig. 5.

With B.S. 2L33 there appears to be a gradual and continuous drop in the value of the endurance limit with increase in testing temperature. With Y-alloy, Lo-Ex and the D.T.D. 424 alloy a noticeable decrease in endurance limit is not observed until a temperature of 200° C. has been exceeded.

The curves given in Figs. 1–4 appear to indicate in most cases that the endurance limit determined at 50 million cycles approaches a fatigue limit. However, in those cases where the endurance limit at 100° or at 200° C. has been higher than that at 20° C. the increase has been due to a heat-treatment effect and such effect may not be permanent for times considerably in excess of that corresponding to 50 million cycles, *i.e.*, approximately 12 days. Further work would be necessary to clear up this point.

Acknowledgments

The authors wish to thank the Chief Scientist, Ministry of Supply, and the Director and Council of the British Non-Ferrous Metals Research Association for permission to publish this paper.

Heat Transfer Investigations on Flame Radiation

AN investigation of the factors affecting luminous flame radiation, using an experimental furnace in the Royal Dutch Steelworks at Ijmuiden, Holland, is being carried out on an international scale. Physicists, engineers, chemists and statisticians of France, Holland and Great Britain co-operated in this work initially; Swedish scientists joined the team later and observers from the United States are interested in the trials being carried out.

Flame radiation is of great importance in relation to the mechanism of heat transfer in furnaces and boilers, but very little is yet known on the subject and an initial fundamental approach was considered to be necessary. At the end of 1948, therefore, it was decided to start this joint research and the Royal Dutch Steelworks made available their experimental furnace, which had been built in 1947/48 for the study of the radiation from oil flames of a size comparable with those in open-hearth steelmaking.

The general plan agreed on for the research was that two kinds of trial should be carried out termed respectively "engineering" and "scientific" trials. In "engineering" trials a large number of independent variables such as fuel rate, kind of fuel (various oils, pitch, pulverised coal, coke oven gas), kind of burner or port, excess air ratio, etc. are altered systematically and a limited number of radiation, temperature and combustion properties of the flame are measured for each flame setting. In "scientific" trials a relatively small number of different flame settings are to be studied in great detail by means of probes so that, for example, the course of combustion of individual droplets, the mechanism of soot formation and the emissivity and temperature of different parts of the flame can be elucidated in detail. It is felt that this more fundamental approach is likely in the long run to lead to results at least as practical as those obtained by the more empirical approach of the engineering trials.

A number of preliminary experiments have now been made along the lines of the scientific and engineering trials. One task has been the choice of the best instruments for the engineering trials, and the equipment of the furnace to the best advantage.

Statistical methods have been used to plan the first series of engineering trials. It was decided to choose five variables (creosote pitch vs oil, high and low combustion air rate, high and low fuel rate, high and low atomising medium flow rate, and air vs steam as atomising medium) and to carry out 48 trials according to a factorial scheme. This has been the first attempt to apply to a large scale furnace these methods of designing experiments, which were originally developed for agricultural trials.

Thanks to extremely hard work and ingenious improvisations on the part of the international team, 47 out of these 48 trials have been successfully completed. The results are now being worked out, and are expected not only to provide valuable scientific information, but also to indicate the next step.

The work is supervised by committees set up in the three countries, each supported by many firms and organisations in their own country. The respective chairmen are:—Professor G. M. Ribaud, of France; Professor O. A. Saunders, of Great Britain; and Mr. J. E. de Graaf, of Holland. A Joint Committee of the three countries has been set up to co-ordinate the work, with Professor Ribaud as chairman, and each National Committee has appointed two representatives. In charge of the research programme as a whole is Mr. M. W. Thring, head of the British Iron and Steel Research Association's Physics Department. Further information on this work may be obtained from:—The Secretary, The Flame Radiation Research British Committee, c/o B.I.S.R.A., Physics Laboratories, 140, Battersea Park Road, London, S.W.11.

Welding Research

THE February, 1950, issue of the above Journal published by the British Welding Research Association contains two informative reports on "Faults in Arc Welds in Mild and Low Alloy Steels" and "A Review of Selected Papers on the Flash and Butt Welding of Light Alloys." In the former the common faults are defined and illustrated and an outline is given of the reasons for their occurrence and of the ways in which they may be avoided and corrected. On the flash and butt welding of light alloys, the second report gives a resumé of recent published information and covers the types of welding machines used for the process, as well as the power and load requirements and settings. Copies of the issues are available from the British Welding Research Association 29, Park Crescent, London, W.1, price 5/6.

Sir George Beilby Memorial Fund Awards, 1949

THE Administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have decided to make three awards, each of 100 guineas, from the Fund for 1949. These awards have been made to:—F. R. N. NABARRO, M.B.E., M.A., B.Sc.(Oxon.), in recognition of his application of mathematical methods to the elucidation of the mechanical properties of metals; CHARLES ERIC RANSLEY, M.Sc., Ph.D.(Lond.), F.I.M., in recognition of his experimental contributions to knowledge of the behaviour of gases in metals; and KEBLE WATSON SYKES, M.A., B.Sc., D.Phil. (Oxon.), in recognition of his experimental contributions to the study of the combustion of carbon and its oxidation by steam.

Costing and Modern Accounting Methods in the Metal Industries

VI.—Providing for Interest on Capital ; Building up Sinking Fund for Plant Replacement

By S. Howard Withey, F.Comm.A.

It is important that account should be taken of the interest on capital in the calculation of depreciation of assets ; otherwise serious consequences may arise. Practical aspects of this problem are considered together with the means which may be adopted for the creation of a sinking fund to enable expansion and modification to plant and premises to be carried out at a later date.

AS part of the all-out effort to close the import-export gap, many metal-producing firms will find it necessary to raise funds for modernisation and development, in spite of the fact that industry in general is expected to limit the amount of capital expenditure. To ignore interest on capital in the computation and recording of depreciation of assets may easily lead to a state of affairs in which, owing to faulty estimates and quotations, the margin of profit actually realised in the fulfilment of important contracts is insufficient to maintain the productive agencies. This, in turn, might cause a serious shortage of capital for essential re-equipment, and in all instances where funds are raised for the specific purpose of acquiring and installing new or additional units or sections of plant, it is advisable to make adequate provision in the metal-producing costs for interest on the capital outlay.

Interest on Capital

When existing factories are developed and mechanised, and when works and depots are brought up to date with the aid of new issues of capital, carrying interest at a fixed rate per cent. per annum, the book values of the assets as shown in the private ledger may be increased, for the time being, by the addition of interest at the appropriate rate, in order that the total cost may be dealt with as capitalised expenditure to be spread over a definite period in the form of equal annual instalments. In this way, the productive operations can be charged with the full and proper cost, and the amounts of annual interest credited separately in the final accounts.

In a recent case, for example, the directors of a company of heat-treatment specialists in the Black Country, with furnaces and works in several districts and no outstanding debentures or mortgages, obtained permission to issue 2,000,000 cumulative preference £1 shares at par. carrying a fixed dividend of 5%. The company's ordinary shares entitled the holders to an unlimited proportion of the available profits after satisfying the claims of the preference shareholders and meeting the prior charges, the preference shares gave the holders the right to any dividends that might fall in arrear, all such arrears being carried forward until paid off. It was decided to allocate the proceeds from the issue in the following way :—

	£
New Workshops	500,000
Furnaces, etc.	613,333
Electrical Equipment	450,000
Elevators and Conveyors	250,000
Machines, Loose Plant and Tools	100,000
Instruments and Laboratory Apparatus	20,000

The existing equipment at the various production centres was reallocated, and at a conference it was agreed to include interest on capital at the rate of 5% in all the cost and contract accounts, and to spread the total burden of capital outlay plus interest over a period of 20 years. It was also desired to do this in such a way that, at the end of the first 10 years, the above assets would have a book value of about £973,333, which meant that £960,000 would have to be written off during this period, after interest at the rate of 5% had been added to the opening balances of the private ledger accounts each year. In order to determine the amount to be included in each year's costings, reference was made to a table, of which the following is an extract :—

TABLE OF DECIMAL PARTS REQUIRED TO WRITE OFF £1 OVER PERIODS RANGING FROM 4–25 YEARS, AFTER CHARGING INTEREST AT VARYING RATES

Years	1%	2%	3%	4%	5%
4.. ..	0·256280	0·262624	0·269027	0·275490	0·282012
5.. ..	0·206040	0·212158	0·218355	0·224627	0·230975
6.. ..	0·172548	0·178526	0·184598	0·190762	0·197017
7.. ..	0·148628	0·154512	0·160506	0·166610	0·172820
8.. ..	0·130690	0·136509	0·142456	0·148528	0·154722
9.. ..	0·116740	0·122515	0·128434	0·134493	0·140690
10.. ..	0·105582	0·111326	0·117231	0·123291	0·129505
11.. ..	0·096454	0·102178	0·108077	0·114149	0·120389
12.. ..	0·088849	0·094560	0·100462	0·106552	0·112825
13.. ..	0·082415	0·088118	0·094030	0·100144	0·106456
14.. ..	0·076901	0·082602	0·088526	0·094669	0·101024
15.. ..	0·072124	0·077825	0·083767	0·089941	0·096342
16.. ..	0·067945	0·073650	0·079611	0·085820	0·092270
17.. ..	0·064258	0·069970	0·075953	0·082199	0·088699
18.. ..	0·060982	0·066702	0·072709	0·078993	0·085546
19.. ..	0·058052	0·063782	0·069814	0·076139	0·082745
20.. ..	0·055415	0·061157	0·067216	0·073582	0·080243
21.. ..	0·053031	0·058785	0·064872	0·071280	0·077996
22.. ..	0·050864	0·056631	0·062747	0·069199	0·075971
23.. ..	0·048886	0·054668	0·060814	0·067309	0·074137
24.. ..	0·047073	0·052871	0·059047	0·065587	0·072471
25.. ..	0·045407	0·051221	0·057428	0·064012	0·070952

Multiplying 0·129505 (required to write off £1 over 10 years at 5%) by £960,000 (the amount to be written off as depreciation) gives £124,324 as the figure to be charged each year, and against this will be set each year's interest on the sum remaining to be written off, as shown below :—

Year	Amount Remaining to be Written off	Interest at 5%	Amount Written off each Year	Effective Depreciation
	£	£	£	£
1st	960,000	48,000	124,324	76,324
2nd	883,676	44,185	124,324	80,139
3rd	803,537	40,177	124,324	84,147
4th	719,390	35,970	124,324	88,354
5th	631,036	31,550	124,324	92,774
6th	538,262	26,910	124,324	97,414
7th	440,848	22,043	124,324	102,281
8th	338,567	16,927	124,324	107,397
9th	231,170	11,558	124,324	112,766
10th	118,404	5,920	124,324	118,404

By incorporating the fixed figure of £124,324 in each year's costings, the total amount debited over the period of 10 years will be £1,243,240, of which a total of £283,240 (as shown in the centre column of the above table) will represent interest, as summarised below :—

	£		£
To Capital Cost	1,933,333	By Amount Written Off	1,243,240
„ Interest	283,240	„ Balance	973,333
	2,216,573		2,216,573

The annual interest items could be credited to profit and loss or credited to a reserve for the replacement of fixed assets after revaluation of the existing profit-earning equipment.

Although the "straightline" method of computing depreciation can often be applied when maintenance costs are fairly uniform, any material increase in the aggregate cost of repairs, renewals, cleaning and overhauling, etc., would call for the application of the "percentage" method for the purpose of equalising the combined charge. When provision has to be made for interest on capital, however, the "annuity" method of computation and accounting is usually more satisfactory from the costing standpoint, although for one reason or another it sometimes happens that no reliable figures can be arrived at by adopting any of these methods, in which case it becomes advisable, for balance sheet purposes, to subject all or some of the assets to a revaluation on the part of qualified engineers or professional valuers.

Many metal manufacturing companies now show, under appropriate headings, the capital cost as at the balancing date, and separately, as a deduction, the aggregate amount provided or written off for depreciation under each head. This is not always practicable when an existing metal business is acquired for a lump sum, as detailed inventories and plant records may not be available to enable the figures to be properly dissected, and in the case of loose tools which are subject to renewal within relatively short periods it may be very difficult to arrive at the actual cost. In any case it is advisable to create reserves to cover repairs and maintenance, even though certain adjustments or alterations are not likely to be put in hand for some time.

Some accounting systems in operation at the present time fail to ensure that all invoices and debiting documents are recorded in the bought day book or purchases journal, and this renders imperative the creation of adequate reserves for all contingencies. When a reserve is made to cover discounts and rebates allowed to customers, the amount to be reserved may be based on the total balances outstanding, as per sales ledger, the percentage corresponding, as nearly as possible, with the ratio which the total sum actually allowed during the accounting period under review bears to the total cash received. Such a reserve should not be shown on the liabilities side of the balance sheet, but should be debited to the discounts and allowances account and deducted from the sundry debtors as shown on the assets side. A reserve may also be made to cover discounts and rebates obtainable from trade suppliers, this figure being usually determined by reference to the total sum outstanding as per purchases or bought ledger; if a percentage is adopted it may be the average rate known to be obtainable, or it may correspond with the ratio which the total of the allowances actually obtained during the period bears to the total amount paid out to creditors. The amount reserved should be credited to the nominal account and deducted from the figure of sundry trade creditors as shown on the liabilities side of the balance sheet.

Provision against debit balances which are uncertain of collection may be made by calculating a percentage of the total balances outstanding, but a more satisfactory method is to examine all the items and compile a separate list of amounts which are either irrecoverable or doubtful of collection, special attention being paid to large items which have been outstanding for an unduly long period.

When trade is brisk and profits relatively high, some portion of the disposable balance should be reserved for the purpose of meeting the difficulties associated with less prosperous periods, such provision being made after adequate sums have been charged for depreciation. Between a reserve and a reserve fund there is a material difference which is not always fully appreciated by executives. Strictly speaking, a reserve is an amount which is charged against profits for the purpose of covering, wholly or in part, an anticipated loss or expense, and such provisions must be made even though the result should be a financial loss or debit balance. On the other hand, a reserve fund is an amount which has been allocated out of profits in order to meet certain contingencies, and it is impossible to build up a reserve fund in any way other than by means of appropriations from profits which have actually been realised.

Creation of a Sinking Fund

To ensure that ample funds will be available for the acquisition and installation of up-to-date plant and machinery, a sinking fund may be created without making inroads on the funds needed for ordinary upkeep and maintenance, and the procedure and principles involved can be clearly presented by referring to an actual case.

At the end of 1948, the plant employed by a firm of metal manufacturers operating in the North had a book value of £955,000, this figure being arrived at after deducting depreciation due to wear and tear, obsolescence and other deteriorating factors. This amount was shown on the firm's balance sheet under the heading of Fixed Assets, and having regard to certain improvements in design and performance effected during recent years it was decided to create a sinking fund for the specific purpose of securing the sum of £1,000,000 in 20 years time for the acquisition of a modern plant layout. Arrangements were accordingly made for the payment

SINKING FUND TABLE

Years	1%	2%	3%	4%	5%
1	1·0000	1·0000	1·0000	1·0000	1·0000
2	0·4975	0·4950	0·4926	0·4902	0·4878
3	0·3301	0·3268	0·3235	0·3203	0·3172
4	0·2463	0·2426	0·2390	0·2355	0·2320
5	0·1960	0·1922	0·1884	0·1846	0·1810
6	0·1625	0·1585	0·1546	0·1508	0·1470
7	0·1386	0·1345	0·1315	0·1266	0·1228
8	0·1207	0·1165	0·1125	0·1085	0·1047
9	0·1067	0·1025	0·0984	0·0945	0·0907
10	0·0956	0·0913	0·0872	0·0833	0·0795
11	0·0865	0·0821	0·0781	0·0741	0·0704
12	0·0788	0·0746	0·0705	0·0666	0·0628
13	0·0724	0·0681	0·0640	0·0601	0·0565
14	0·0669	0·0626	0·0585	0·0547	0·0510
15	0·0621	0·0578	0·0538	0·0499	0·0463
16	0·0579	0·0536	0·0496	0·0458	0·0423
17	0·0543	0·0500	0·0460	0·0422	0·0387
18	0·0510	0·0467	0·0427	0·0390	0·0355
19	0·0481	0·0438	0·0398	0·0361	0·0327
20	0·0454	0·0412	0·0372	0·0336	0·0302
21	0·0430	0·0388	0·0349	0·0313	0·0280
22	0·0409	0·0366	0·0327	0·0292	0·0260
23	0·0389	0·0347	0·0308	0·0273	0·0241
24	0·0371	0·0329	0·0291	0·0256	0·0225
25	0·0354	0·0312	0·0274	0·0240	0·0210

of 20 annual premiums carrying compound interest at the rate of 3%, and in order to determine the amount to be paid each year, reference was made to the Sinking Fund table which gives the decimal part needed to earn £1 over periods ranging up to 25 years, after allowing for interest at varying rates, and the amount of the annual premium was arrived at by multiplying 0·0372 by 1,000,000, giving £37,200. Each year, this amount will be debited direct from the firm's cash book to an investment account opened in the private ledger, the plant account remaining unaltered during the entire period and the usual charge for depreciation being replaced by a debit in each year's profit and loss account equal to the amount of the annual premium. These amounts will be credited to the sinking fund account, and each year the interest on the investment will be calculated and debited to the investment account and credited to the sinking fund, so that at the end of 20 years the latter will amount to £1,000,000, of which £955,000 will be transferred to the credit side of the plant account, leaving a balance of £45,000 as a reserve. Upon realising the investment, the amount of cash received will be posted from the debit side of the cash book to the credit of the investment account, which will then be ruled off, the money being available for the acquisition of a modern layout, the capital cost of which will be debited to the plant account in the usual way. The figure debited to profit and loss each year will probably not be allowed to stand as a deduction for purposes of assessment under Schedule D of the Income Tax code, and the next article will indicate procedures for determining the balance of taxable profit.

The Aluminium Development Association

AT the recent Annual General Meeting of the above Association, the retiring President, Mr. Kenneth Hall, gave a very encouraging report of activities during 1949. The year had seen the organisation and position of the Association further consolidated and the general pattern of development more clearly defined, in spite of difficulties encountered. Certain major developments, however, have been in part suspended or delayed by the incidence of devaluation and the consequent rise in the cost of aluminium. But although fruition of some of these projects may be retarded until the situation becomes more stabilised, this has in no way occasioned any slackening of the Association's fundamental development work. In fact, the interval is being profitably employed in achieving solutions to hitherto unsolved problems—such as riveting and welding of thick plate, or the fuller introduction of new techniques such as argon arc welding—essential to the ultimate full exploitation of these virtually untapped outlets in which the metal should achieve its highest value.

The past year has constituted another record in the amount of information disseminated in all the ways open to the Association—publications; lectures; film shows; publicity and enquiries—all have played their part. The production of British Standards involving aluminium made good progress, indicating the acceptance of aluminium in many fields. Educational activities show a marked increase and there are now some 400 schools on the Association's list receiving various forms of visual and other assistance. The issue of educational films increased by 25% whilst technical lectures by the staff were maintained at the high level of the previous year.

Major inquiries during the year totalled more than 3,500, of which the largest number, 790, were concerned with building and structural applications. In the marine field, contact has been maintained with shipyards, shipowners and various official bodies, whilst in the railway and mining fields useful technical progress is recorded. In road transport, technical contacts have again assisted further developments, particularly in the provision of stock sections for vehicles. The more ambitious developments it had been hoped and planned to achieve may have been temporarily arrested by the far-reaching effects of devaluation. Nevertheless, the Association has progressively pursued the fundamental policy laid down at its inception, that technical co-ordination and unified advance in development are the surest insurance for securing the ultimate success of aluminium whether full use of the metal is achieved early or late.

The new President is Mr. Edward Player, Managing Director of Birmid Industries, Ltd., who has represented that Company on the A.D.A. Council since 1945. Mr. E. Austyn Reynolds who was elected Vice-President represented T.I. Aluminium, Ltd., on the A.D.A. Council and for some years was also a member of the Executive Committee. Mr. F. G. Woollard was re-elected as Chairman of the Executive Committee.

International Sales Convention

DELEGATES from many countries abroad, as well as a strong United Kingdom contingent, will attend the 1950 Sales Convention of the Driver-Harris organisation, which opens at Alderley Edge, Cheshire, on May 10th. This Convention is of special significance in view of the greatly increased export movement of Driver-Harris products and the need, in such an international organisation, for close co-operation with the associate companies.

In additions to discussions on domestic questions, such as production, deliveries, distribution and publicity, there will be discussions on new alloys produced during the past year and on the widening field of application of the Company's specialist service on nickel and nickel alloys. A particularly timely subject in the programme will be the effect of currency devaluation and the problems of the world economic situation.

The Nimonic Series of Alloys

MESSRS. HENRY WIGGIN & CO., LTD., of Birmingham, recently issued three more publications on the important Nimonic series of alloys. They give details of methods for annealing and pickling, hot-working and machining these alloys. That on machining was compiled as a result of a survey of current practice in the machining of these materials by a number of prominent aircraft engine manufacturers.

These publications will be of considerable interest to the growing number of firms who fabricate these materials for high temperature service, giving as they do valuable data on the most satisfactory method of management. Any, or all of them, may be obtained, free of charge, on application to Henry Wiggin & Co., Ltd., Wiggin Street, Birmingham, 16.

Staff Changes and Appointments

MR. BRIAN DAVIDSON, B.A., business manager of The Bristol Aeroplane Co. Ltd. since December, 1946, has been appointed Director of the Company. During the war he served with the Air Ministry and Ministry of Aircraft Production, at first as head of a division set up to finance emergency reconstruction of blitzed factories and supervising dispersal of production. He was seconded for special planning duties on the extension of Bomber Command and later became Chief Administrative Officer (Engines).

PROFESSOR SIR IAN HEILBRON, D.S.O., F.R.S., has been appointed Chairman of the Advisory Council for Scientific and Industrial Research in the place of Sir Geoffrey Heyworth who resigned owing to pressure of other public duties.

MR. W. V. GOLDING has been appointed Traffic Superintendent of Dorman Long and Co. Ltd., in succession to Mr. A. C. W. Impey, who recently retired. Before joining the Company in 1946, Mr. Golding was chief traffic controller, Darlington District, L.N.E.R.

MR. H. P. HUGHES, late Foundry Manager and Metallurgist with Messrs. Thomas Robinson and Son Ltd., Rochdale, has joined the technical staff of British Electro Metallurgical Co. Ltd. as Foundry Consultant.

Messrs. Guest Keen Baldwins Iron and Steel Co. Ltd. announce the retirement after nearly 40 years' service of MR. J. B. DEAKIN, Works Manager at East Moors Works, Cardiff, and the appointment of MR. W. C. SMITH in his place. Formerly Assistant Works Manager at East Moors, Mr. Smith joined Guest Keen Baldwins Iron and Steel Co. Ltd. in 1935 from the Templeborough Branch of the United Steel Companies Ltd. when he became Mills Manager of the then new Mills at East Moors. He became Assistant Works Manager in 1947.

MR. H. J. NICHOLS, C.I.E., D.Sc., M.Inst.C.E., A.M.I. Mech.E., has been appointed Registrar and Secretary of the Professional Engineers Appointments Bureau of 9, Victoria Street, S.W.1, with effect from March 8th.

MR. A. A. H. DOUGLAS, B.Sc. (Eng.), A.M.I.Mech. E., has been appointed Director and General Manager of the Distington Engineering Co. Ltd., Chapel Bank Works, Workington, Cumberland, manufacturers of mining machinery and iron founders.

MR. FRANK PARR, who now fills an executive position with the British Iron and Steel Federation, has joined the Whitehead Iron and Steel Co. Ltd., and its Associated Companies as a Special Director.

MR. E. S. WADDINGTON, F.S.E., M.Inst.W., A.M.I.E. (S.A.), Associate I.E.E., Associate (S.A.), I.E.E., of the Industrial Department of Philips Electrical Ltd., has been appointed British Representative of the International Institute of Welding for Commission No. 8.

MR. CYRIL C. MASSEY, who was Assistant Manager Commercial Division (Sheet Sales) for Richard Thomas and Baldwins Ltd., has been appointed Sales Manager, Sheet Department of The Steel Company of Wales Ltd. and will commence his duties on 1st May, 1950. MR. ARTHUR J. JENKINS will continue his duties as Sales Manager of Heavy Steel and other products.

MR. R. E. CARR has appointed MR. B. L. PAGE, General Manager of the Foundry Section of John Dale Ltd., as alternate Director to himself, and this has been confirmed by the Board of Directors.

DR. R. HARGREAVES has joined Tiltman Langley Laboratories Ltd., Redhill, as Chief Metallurgist. Dr. Hargreaves, who has specialised in high temperature corrosion, was Metallurgist for the Aviation Department of Shell Refining and Marketing Co. Ltd. from 1940 to 1945, and then became Technical Manager of the Aero Piston Ring Co. Ltd., Leeds.

MR. D. C. EMBLEY, Advertising and Publicity Manager, High Duty Alloys Ltd., has completed arrangements to join H. W. Carter and Co. Ltd., Coleford, Gloucestershire, as Advertising and Publicity Manager within the next few months. He will continue to be responsible for the advertising affairs of High Duty Alloys Ltd. until the change takes place.

Obituary

MANY readers will learn with regret of the recent death of Mr. William Milne who was, for many years, a well known executive of British Driver–Harris Co. Ltd. He joined the staff of the organisation at Manchester during the first World War. In 1923, he was appointed Sales Director, a post he held for 25 years. In 1946 he was promoted a director of the Company. Mr. Milne, probably the most widely-travelled member of the British Driver–Harris organisation, retired from the Board of the Company in September, 1948.

Sir William J. Larke Medal

THE Council of the Institute of Welding have awarded the Sir William J. Larke Medal, for the best paper read to the Institute during the year, to Mr. R. G. Braithwaite, M.I.C.E., M.Inst.W. Mr. Braithwaite is welding Consultant to Braithwaite and Co. (Structural) Ltd., and was last year Chairman of the Birmingham Branch of the Institute. His paper deals with the control of distortion in arc welding.

British Industries Fair

Birmingham Section (*continued from page* 392)

In addition to cutting oils, lubricants, and insulating oils, GULF OIL (GREAT BRITAIN), LTD. will be showing on Stand D 737 a range of preservatives for metals. Of special interest in this group is " Rubberlube " for the protection of metal parts containing rubber. Unlike ordinary greases prepared from mineral oils, " Rubberlube " has no ill-effects on the rubber.

On Stand 1345/1244 Outdoor, SHELL MEX AND B.P., LTD. display a selected range of sample packages and literature dealing with Shell industrial lubricants. The stand will also form a convenient base for giving practical service to the numerous Shell users who are exhibiting, and for information and advisory services.

Various aspects of the VACUUM OIL CO., LTD.'S lubrication service to industry will be shown on Stand D 146. Besides a range of lubricants, Delvac mechanical lubricators and process products for various trades will be on view.

J. B. & S. LEES, LTD. on Stand D 327 will be showing a wide range of hardened and tempered steel-strip products which are used for the manufacture of all types of band saw, hand saw and a variety of hand tools. There will also be typical examples of special deep stamping and pressing strip together with " Trident " brand lead-coated steel strip.

LABORATORY METHODS
MECHANICAL · CHEMICAL · PHYSICAL · METALLOGRAPHIC
INSTRUMENTS AND MATERIALS
MAY, 1950 Vol. XLI No. 247

British Scientific Instruments Exhibited at Olympia

The Frontiers of the Field of Applied Science

Exhibits of some sixty members of the Scientific Instrument Manufacturers' Association will be shown on a composite stand covering more than 10,000 sq. ft. at the Olympia section of the British Industries Fair. The central feature of this comprehensive display will be a stand, sponsored by the Ministry of Supply, showing atomic energy developments.

THE Scientific Instrument Exhibit at the 1950 British Industries Fair is being staged as usual under the aegis of the Scientific Instrument Manufacturers' Association of Great Britain. One of the most valuable consequences of this central sponsorship lies in the fact that there are being shown products of a whole industry rather than an unco-ordinated exhibit of the individual products of firms within the industry. Scientific instruments are of a most diverse character, and specific classes of instruments make particular appeals to sectional interests of instrument users. The carefully considered internal grouping of the exhibit leading as it does to a display related to the interests of the user makes for greater convenience and economy of time and effort of the visitor.

The background of the production of scientific instruments has three main aspects. In the first place, every instrument is based upon some principle which has been established through the advancement of scientific knowledge; Great Britain has played a pioneer and notable part in extending the frontiers of science. In the second place, the application of scientific knowledge to the production of scientific instruments or to any other product of the industry demands the services of technology; this modern aspect of industrial methods has its genesis in the industrial revolution which took place in Great Britain some century and a half ago. Finally, craftsmanship plays a major part in scientific instrument manufacture, and craftsmanship has been the pride of the industry since the Middle Ages. History and tradition, therefore, provide a most favourable soil for the production of British scientific instruments, and the exhibit at the 1950 British Industries Fair indicates that all skill and effort have been employed to cultivate that soil in a most efficacious manner.

Every phase of human activity is to-day influenced by the application of science, and the section provides, as it were, a bird's eye view of the frontiers of the field of applied science, and in doing so it reveals the amazing ubiquity of scientific instruments.

Electronic Equipment

Recent years have seen the cathode ray tube advance from a scientific curiosity to an indispensable component of a large number of instruments designed for laboratory and industrial purposes, to say nothing of its use in the home in the television receiver. Whilst it would be an exaggeration to say that it is as widely used as the ordinary ammeter or voltmeter, it is nevertheless true that the laboratories in which the cathode ray tube finds no application are rapidly diminishing in number. This is reflected in the exhibits shown by the scientific instrument manufacturers at Olympia.

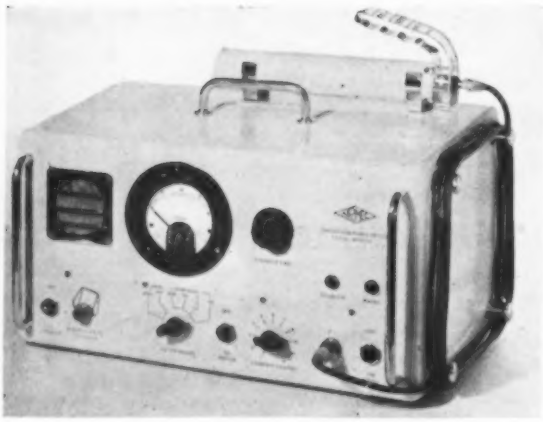
A D.C. Oscilloscope (Type 723) to be shown by AIRMEC LABORATORIES, LTD. (C 14)* employs a 4-in. electrostatic tube with an optically flat screen and provision for direct connection to the deflecting plates. The maximum sensitivity is 10 mV/cm. at 1 kV. and there is provision for operating at 2 and 4 kV. An attenuator control giving 0, 1/10 and 1/100 fixed settings and a variable gain control, range 0–20 db. are fitted. A two-stage balanced Y amplifier having a gain-frequency response flat from D.C. to 5 Mc/s. and an auxillary Z amplifier giving a gain of some 30 × which may be used for extending the X trace are also fitted. The time base is variable from 1 second to 1 micro second single sweep and the fly-back is fully blacked out over the entire range. Provision is also made for a single stroke time base and for internal or external automatic synchronisation.

Two Signal Generators, H.F—Type 701 and L.F.—Type 702, have ranges of 30 kc/s.–30 Mc/s. (in seven bands) and 30 c/s.–30 kc/s., respectively. In the H.F. generator the frequency accuracy is ± 1% and output up to 1 volt is available. A screened constant impedance output attenuator of 75 ohms is provided and for modulation, the depth of which is variable from 0–80%, provision is made for internal modulation at 1,000 c/s. and for external modulation at 30 c/s. to 12 kc/s. on frequencies above 100 kc/s. The output of the L.F. generator is 15 volts at open circuit and the output impedance 600 ohms with an attenuator which operates under balanced and unbalanced conditions. The stability is ± 0·5% after 2 minutes warming up and the distortion less than 2% from 100 c/s. to 10 kc/s., (less than 5% on other frequencies).

A Stabilised D.C. Power Supply Unit (Type 705) to be shown by Airmec provides a constant D.C. voltage continuously variable between 200 and 350 volts with an output of 200 mA. at voltages up to 250 volts and 100 mA. at 350 volts. Changes of ± 10% in mains or load cause a variation of ± 0·5% in output.

An instrument giving increased convenience to L.F. bridge users is the Bridge Oscillator, Amplifier and

* Details in parenthesis denote the Stand No.



Airmec Type 1021 radiation monitor.

Detector (Type 703) incorporating these three items and a power unit in one case, and suitable for use with Wein, Campbell and other L.F. bridges. The oscillator output is 100 milliwatts at 1,500 c/s. A meter is fitted for visual detection and provision is made for 'phones where greater sensitivity is required.

A high impedance general purpose Valve Voltmeter (Type 712) has the following ranges: *A.C. volts*—0–1·5, and four others up to 150. *D.C. volts*—0–5, and two others up to 500. *Resistance*—0–1,000 ohms, and five others up to 100 megohms. It is suitable for use on frequencies up to 200 Mc/s.

The Airmec Electronic Counter (Type 704), which is suitable for industrial counting, scaling, testing Geiger tubes and accurate high-speed timing has a normal counting rate up to 3 million per minute or up to twice that rate if required. There are no moving parts and the small output from a photo-cell or Geiger tube will operate it. The Electro-Mechanical Counter (Type 737) counts up to 999,999 at rates up to 1,000 per minute. The decades are plug-in type and interchangeable, thus prolonging the life of the counter. No additional mechanical load is involved in changing from 9–10 on any unit.

The Process Timer (Type 623) is suitable for industrial or laboratory processes and is entirely electronic. It is calibrated from 10–180 seconds and handles a load of up to 3 amp. at 250 v. A.C.

For audio frequency measurements and high-speed revolution counting the Frequency Meter (Type 726) will be shown. Three ranges cover 0–20,000 c/s. or 0–1,200,000 r.p.m. and the instrument can be used with electro-mechanical or photo-electric pick-ups. The input signal voltage may be from 0·1–20 volts peak.

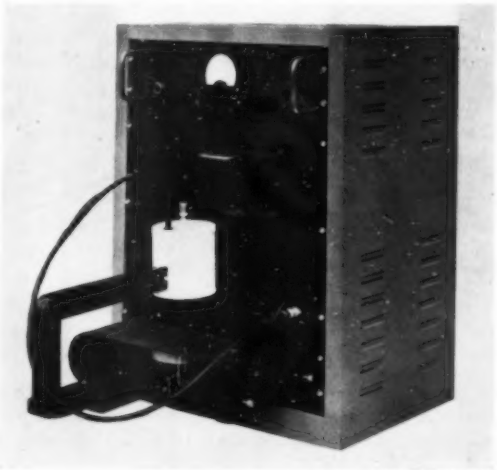
An Ionisation Voltage Tester (Type 732) and an Audio Power Output Meter (Type 708) will also be shown.

The increasing use of radio-active materials in many branches of scientific work has resulted in the development of the Radiation Monitor (Type 1021), designed at the A.E.R.E., which indicates the presence of radio-active materials and is suitable for comparative or absolute measurements. A probe is provided which is sensitive to Beta particles and to Gamma-ray, whilst a probe for detecting Alpha particles is also available. An accurately calibrated meter gives readings in radiation counts per second and audible indication is also provided for use when meter reading is inconvenient. The first range is 0–2 counts per second and three other ranges cover up to 0–2,000 counts per second.

Further electronic exhibits will be featured on Stand C 52 by E. K. Cole, Ltd. The Cathode Ray Oscillograph, 1089A is primarily intended for monitoring the pulse wave forms met with in Nucleonic investigation, but is equally useful wherever a general purpose C.R.O. is needed. Most of the provisions of a normal C.R.O. are contained in this instrument except that there is no built-in *X* Amplifier. Used with the Ekco Linear Amplifier type 1008A, it has a deflection sensitivity and frequency response considerably better than the normal general purpose C.R.O.

The Vibrating Reed Electrometer, 1079A, has a greatly improved zero stability as compared with other types. The applied D.C. is converted into A.C. by means of a vibrating condenser, the A.C. being amplified and then rectified. Stability is increased by the application of negative feedback. Direct indication of the voltage or current being measured is given on a 3½-in. panel meter and simultaneously a recorder and/or a process controller may be operated. Many problems involving the measurement of small direct currents and voltages can be solved with this instrument, including those associated with *p*H measurements.

A range of isotope containers, lead castles, screening blocks and Geiger-Müller tubes will be displayed together with a complete self-contained apparatus for the accurate measurement of radio-active isotopes using a methane flow counter, linear amplifier, scaler, power unit and C.R.O. The Scaler (1009 A) is capable of counting up to 40,000 counts per minute using two electronic decades and a mechanical register. The Linear Amplifier (1008 A) consists of a main amplifier unit and two head amplifiers, either of which may be used according to requirements. The maximum voltage amplification is 1,600,000 and this is constant within 3 db. over the frequency range 20 c/s. to 500,000 c/s. The Power Unit (1033 A) is of the H.F. oscillator type with a specially designed feedback amplifier for stabilization. The output voltage is continuously variable from 500–3,000 volts and is virtually unaffected by mains variations up to ± 10%.



Courtesy of E. K. Cole, Ltd.

Radioactive thickness gauge.

Three models of Radiation Monitor will be shown. The 1043 C Model is completely self-contained and portable and is suitable for the measurement of Gamma-dosage and for the qualitative detection of Beta-radiation. The instrument, which is made to an A.E.R.E. design, has two ranges, the full-scale readings being 0·125 and 1·25 roentgens per hour. The 1118 A model has two ranges with full-scale readings of 15·0 and 150 milliroentgens per hour, as are those of the 1132 A Monitor, which is designed for use with X-rays, and will give accurate indications of dosage of very soft radiation.

Of particular interest to strip rollers is the Ekco Radio-active Thickness Gauge which obviates the need for mechanical contact between the gauge and the material to be measured. The radio-active source is placed on one side of the material and an ionisation chamber on the other, the amount of radiation absorbed depending on the thickness of the material. The Ekco instrument makes use of a differential bridge method, utilising two sources, two ionisation chambers and a vibrating reed electrometer. It is ideal for measuring continuously moving materials and an accuracy of 1–2% can easily be obtained at speeds of 5–6 ft./sec. Recording and controlling versions are also possibilities.

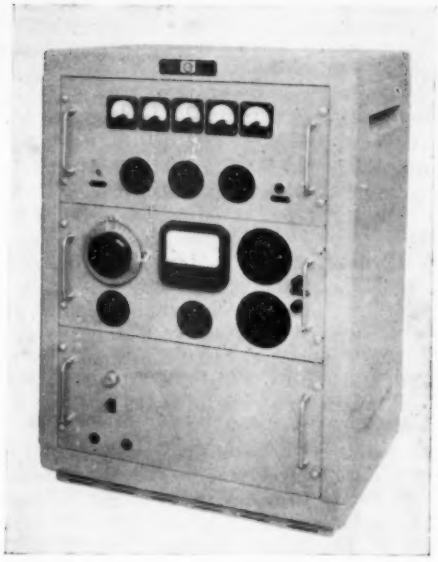
The instruments to be shown by CINEMA-TELEVISION, LTD. on Stand C 49 ably demonstrate the many applications of electronics to both research and industry. A new range of portable Metal Detectors are being shown for the first time. The standard model for general use—timber yards, gas and water undertakings, etc.—now incorporates a 50-cycle noise suppression filter. This is essential when tracing metal which is situated near power cables. Another model is used for detecting pipes and cables buried to a depth of 30 ft. below the surface. The Industrial Electronic Metal Detector for locating minute pieces of ferrous or non-ferrous metal in foodstuffs, plastics, confectionery, etc., will also be demonstrated.

Of the many instruments for research and laboratory use on show, three deserve special mention. The first is the Universal Valve Tester. This equipment will display on a cathode ray tube a family of Ia/Va curves for any type receiving valve. Curves for eleven different grid voltages are shown simultaneously and a calibration pattern is also displayed enabling the valve characteristics to be checked. Variable supplies are also provided enabling the Ia/Va curves for any receiving valve working under any condition to be seen. The second is an R.C. Oscillator with a frequency range of from 10 c/s. to 100,000 c/s. The feature of this instrument is that the output frequency is measured by an automatic monitor and displayed on five panel meters each scaled from 0–9. The monitor continually samples the oscillator frequency and presents the exact value every 5 seconds.

The third is the Microsecond Counter Chronometer. This instrument will measure time in the range 1 μs. to 1 second and 10 μs. to 10 seconds with a very high degree of accuracy. It can also be used for high-speed counting—the maximum counting rate being 1,000,000 per second—for delivering pulse trains, frequency division, frequency multiplication, etc.

Numerous other instruments including Oscilloscopes, Power Packs, Scalers, Bridges, Cathode Ray Tubes, etc., will also be shown.

Cintel R.C. oscillator and Automatic frequency monitor.



On Stand C 42, 20TH CENTURY ELECTRONICS will be showing their complete range of Geiger Counter Tubes. The Halogen Quenched Low Voltage Counter Tube (G. 10H) has been developed for portable and prospecting apparatus and has increased life compared with normal argon/alcohol tubes. In the Low Temperature G.M. Tubes (B.6E, B.12E, G.12E, G.26E and G.60E) ethyl bromide has been introduced as a quenching agent, thus enabling the tubes to work down to — 20° C. The threshold of an ethyl bromide quenched tube (with carbon electrode) rises approximately 1 volt per 1° C. temperature rise, which is also better than with ethyl alcohol quenching. On the other hand, the efficiency of the alcohol quenched Beta counter tube is 100% as against 70% for the ethyl bromide tube.

The Demountable Type Tube (D.M.6) is a thin-walled Beta counter in which a surrounding test-tube is fitted to the envelope by means of a ground glass joint. Beta counts can be taken directly from a 10 ml. sample of liquid poured into the test tube.

The Immersion Type Tube (B.24) is also a thin-walled Beta counter, wall thickness 30–40 mg./cm.^{2} in which the length of thin wall is 24 cm. It is available for use in monitoring large areas or where samples deposited on filter papers have to be wrapped round the largest area possible.

The Gas Analysis Tube (GA.26) is designed to work with ^{14}C and is an internal Beta counter.

A selection of experimental tubes, including types not fully standardised will also be shown.

The Cathode Ray Tubes exhibited will include single beam flat-ended electrostatic tubes (S6B and S4B) with screen sizes 6 and 4 in., which have been designed to fulfil the need for precision instruments of the highest possible quality and embody a number of novel features. The double-beam type (D6B) incorporates two completely independent sets of work plates and is intended for the examination of two phenomena coincident in time, where a beam switching arrangement would not be practicable. The two beams are accurately aligned and completely free from intermodulation.

The Valve Voltmeter (Type 613) shown by Dawe Instruments, Ltd. (C 18) is a sensitive meter covering a voltage range of 1 millivolt to 300 volts with protection for the meter against occasional overloads of several hundred times normal. The high-frequency response is maintained up to 1·5 Mc/s. by the use of miniature valves, the lower frequency limit being 10 c/s. The A.C. input, on which the instrument places negligible load, may have up to 750 volts D.C. superimposed.

On the same stand will be shown a Wide Range Oscillator (Type 400) which is directly calibrated on a scale covering 300°. Resistance tuning is employed in the R.C. oscillator, this type of circuit obviating the magnification of drift normally found on an oscillator of the beat-frequency type. Three models are available: Model A—20 c/s. to 20 kc/s., with output of 1 watt; Model B—20 c/s. to 200 kc/s., with output of 100 milliwatts; and Model C—0·1 c/s. to 1,000 c/s., with output of 100 milliwatts.

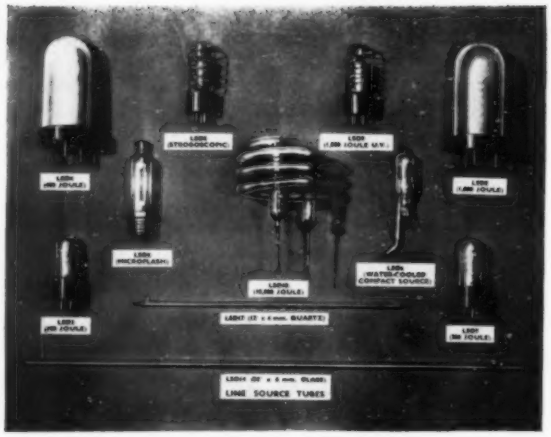
For a wide variety of applications in the field of nuclear research and for the examination of transient conditions in many types of electronic equipment, the Pulse Generator (Type 412) provides rectangular pulses of 1, 10 or 100 microseconds width, available at a repetition rate of 1–2,500 c/s., the pulse amplitude being variable between 0 and 75 volts and read from a directly calibrated output meter. Alternative output sockets provide a choice of negative- or positive-going pulses and provision is made for the connection of an external oscillator so that the repetition rate may be extended to 10 kc/s.

Other electronic instruments exhibited by Dawe Instruments, Ltd. included the Production "Q" Comparator (Type 620), designed for the checking and matching of coils and condensers under mass production conditions; and the Type 622 and 623 "Q" Meter, enabling measurements of coil "Q" and inductance; condenser capacity, power factor and inductance; dielectric loss of insulating materials; and the characteristics of transmission lines to be made. By means of the Universal Impedance Bridge (Type 314) shown, direct readings of inductance, capacity, resistance, coil magnification factor and condenser power factor, may be made, whilst indirect measurement of condenser loss resistance and leakage resistance is also possible.

British Electronic Products (1948), Ltd. (H 30) will show a new range of high-speed scaling equipment which is available in unit form for experimental laboratories. The units range from single skeleton construction binary units to complete decades with indication or preselection of the count.

On Stand C 69 Mullard Electronic Products, Ltd., will be exhibiting a wide variety of electronic devices designed for use in industry and research.

The range of photocells exhibited offers wide possibilities in industry and research for such applications as counting and batching; sorting by various standards such as size and colour; quality control; and the rapid and accurate inspection of mass-produced articles. The daylight-sensitive types with caesium/antimony cathodes also offer great scope for colorimetric and photometric measurements, and spectrophotometry. The principal types are available in two sizes, the large "20" series on loctal (B8G) bases and the "90" miniature series on button (B7G) bases. Two new cells, the 58CV and 58CG, are specially designed for an end-on aspect of illumination. These cells are not much larger in diameter than an ordinary pencil, and are particularly suitable for use in conjunction with extremely small and compact lens systems. Of particular interest among the thyratrons exhibited are two mercury vapour triodes, the 0·5-amp type MT17, and the 2·5-amp type MT57, suitable for use in motor-control systems. A miniature gas-filled tetrode 2D21 is also available for thyratron applications where the conservation of space is of particular importance. A high voltage version of the cold cathode thyratron 1267 will also be displayed.



Mullard range of electronic flash tubes.

A smaller but no less important group of exhibits are the electrometer valves which form the basis of a wide variety of *p*H meters, valve voltmeters and other high-resistance apparatus. The large range of flash tube exhibits includes a 10,000 joule flash tube, LSD10, which has a light output of 600,000 lumen seconds, and a stroboscopic tube, LSD8, which has a flash speed equivalent to 30,000 r.p.m. and a continuous rating of 30 watts.

For use in compact lightweight communications and industrial electronic equipment the range of sub-miniature valves will be of interest, as will the small hard-glass transmitting valves which are, for their size, among the most efficient valves in existence.

Prominent among the group of electronic equipments displayed is a new Low Frequency Magnetrostriction Ultrasonic Generator. The almost unlimited field of ultrasonics in industrial processes opened up by this generator is due almost entirely to the design of the transducer unit—the element by means of which the ultrasonic power is transmitted to the medium being treated—which is composed of a stack of nickel laminations somewhat resembling a transformer core. Although the transducers at present available are limited to powers of about 1 kW., and are intended primarily for experimental use, it is quite possible to design special transducers delivering much higher powers and suitable for specific industrial applications. The possible applications so far envisaged include: the emulsification of a wide variety of normally immiscible substances; the precipitation of solids in liquids, and the promotion of free flow in powders and thixotropic substances. The new Mullard transducers may also be applied to a number of cleansing processes.

Another extremely important development in the field of ultrasonics is the Mullard Ultrasonic Soldering Iron. This soldering iron solves the problem of soldering aluminium and other metals which form oxide films.

Among the measuring instruments displayed is a Conductivity Bridge employing a modified Wheatstone bridge operating at a test frequency of 2·5 Kc/s. Balance is aided by means of a " magic eye " indicator. An industrial conductivity controller is also displayed housed in a rigid case and incorporating a relay for the control of external circuits such as valves, alarms, indicators, etc.

Another important exhibit is the new Mullard H.F. Oscilloscope Type E7581. This instrument embodies a cathode ray tube with a useful screen diameter of 13 cm. providing a blue-white trace suitable for visual or photographic work. Other instrument exhibits include an entirely new, and extremely accurate, concentric cylinder type viscometer, providing remote readings ; and a Valve Volt-ohm Meter with special zero-setting characteristics.

The Ionex ionisation chamber shown by the BALDWIN INSTRUMENT CO., LTD. (C 5) is a mains-operated precision measuring instrument. It consists of a stable D.C. feedback amplifier with electrometer valve input stage and a wide range of interchangeable ionization chambers, for Alpha, Beta and Gamma and X-rays. A Weston cell is incorporated and facilities are provided for checking the current as well as the voltage calibrations.

The Gamma Radiation Detector (Type PP) is a compact, portable Geiger-Müller counter designed primarily for prospecting. A low voltage G-M tube, and cold cathode valve amplifier, are used to ensure long life of the dry batteries. An indicating instrument with approximately logarithmic calibration is also incorporated in the hermetically sealed case and a socket is provided for headphones to give audible signals at very low counting rate.

For measuring the stray Gamma or X-radiation received by individuals exposed to such radiations a fountain-pen type Pocket Ionisation Chamber will be shown. It is hermetically sealed and desiccated and a diaphragm is provided for contacting the highly insulated centre electrode. For use in conjunction with the chamber, a compact Valve Electrometer will be shown, which serves for charging the chambers as well as for measuring the residual charge after exposure. The dose is shown on an indicating instrument calibrated in milliroentgens.

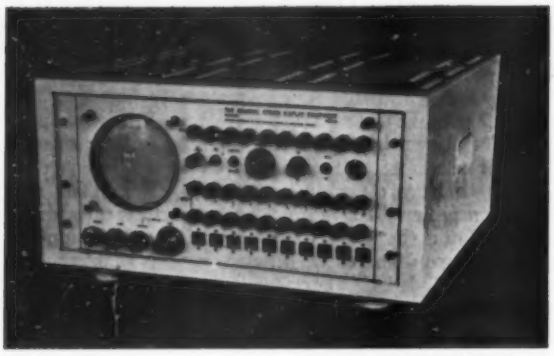
The Beta-ray thickness gauge provides a very convenient means for measuring the thickness of numerous materials—e.g., paper, plastic sheets and metal foils. It can be used for gauging sheets as well as for continuous indication, recording or control of strips. A radio-active isotope emitting hard Beta rays is used as the source of radiation, which falls on an ionization chamber a short distance away. If a sheet of material is placed between these the radiation will be partly absorbed and the ionization current produced in the chamber will accordingly decrease. The absorption is a measure of the mass per unit area or thickness of the sheet.

The exhibits of SOUTHERN INSTRUMENTS, LTD. (C 44) will include a number of items from their Minirack range. The wide application of the resistance strain gauge has resulted in the demand for a drift free high-gain direct-coupled amplifier system for use with cathode-ray oscillographs to record small D.C. potentials. Difficulty has been encountered in the past in obtaining an amplification of 50,000 or more without excessive drift making the resulting measurements inaccurate or impossible. In the Drift-corrected Direct-coupled Amplifier shown by Southern Instruments the arrangement of the Minirack oscillographs has made it convenient to have separate panels for pre-amplifier and driver amplifier. At present only the former is drift-corrected and the latter depends for its stability on the use of balanced stages with negative feed-back, and on valve-stabilised H.T. supplies. In the MR235 D.C. pre-amplifier a good quality direct-coupled valve amplifier is used in conjunction with a chopper circuit which detects and corrects for any drift that may take place. In this way it retains the wide frequency band of a normal amplifier together with a stability approaching that of a chopper amplifier. The MR209 D.C. driver amplifier is of the standard type designed to produce the large voltages required to drive the deflecting plates of a C.R. tube and consists of a two-stage balanced circuit using four valves with individual negative feed-back to ensure stability and linearity.

TAYLOR ELECTRICAL INSTRUMENTS, LTD. (H 38) will be exhibiting a selection from their range of instruments which includes a number of electronic items. The Model 3A Cathode Ray Oscillograph has a 3½-in. electrostatic tube with a green trace. A continuously variable linear horizontal sweep is provided covering 10–10,000 c/s. A single-stage push-pull amplifier feeds the vertical deflector plates and two input attenuators are provided, the course having three steps marked X1, X10 and X100, and a fine control covering from zero to maximum gain. The maximum voltage gain is about 120. The amplifier response is practically linear from 10–20,000 c/s. and gives useful amplification up to 10 kc/s. Provision is made for the time base to be synchronised either with an external source, internally or with mains frequency. The average impedance on the vertical input is 1·5 megohms, and on the horizontal input, about 5 megohms. A connection panel at the back gives direct access to the tube deflecting plates. With direct connection, the horizontal sensitivity is 0·35 volts A.C. per mm. and vertically is 0·5 volts A.C. per mm.

The Model 170A Electronic Meter is a mains-driven valve voltmeter covering a wide range of D.C., A.C. and resistance measurements. The input impedance on R.F., A.C. and D.C. is high and the instrument is accurate up to very high frequencies. Similar, but with additional facilities for using the moving-coil instrument as a multi-range universal meter is the Model 180A Electronic Meter and Multirange Universal Meter. Other exhibits of interest in the electronic field will include a range of instruments for testing valves.

On Stand H 30 (BRITISH ELECTRONIC PRODUCTS (1948), LTD.), a working model of a complete electronic control scheme for the coiling and uncoiling of strip material will be in operation, showing methods of obtaining constant linear speed and constant tension characteristics despite the build up of material on the driven reel. The actual linear speed of the material can be manually varied over wide ranges and can also be automatically controlled to obtain a specific result



Courtesy of Elliott Bros. (London), Ltd.

10-channel strain gauge display unit.

where the strip or web material is being processed during its travel. Installations of this type may range from very large equipments for handling steel strip, to very small units utilised in the textile industry.

Apart from this demonstration models of a new series of electronic motor speed control equipment will be shown. This type of equipment is available in sizes from fraction to 30 h.p. and any unit can be provided with a wide range of control features.

Electro-mechanical Equipment

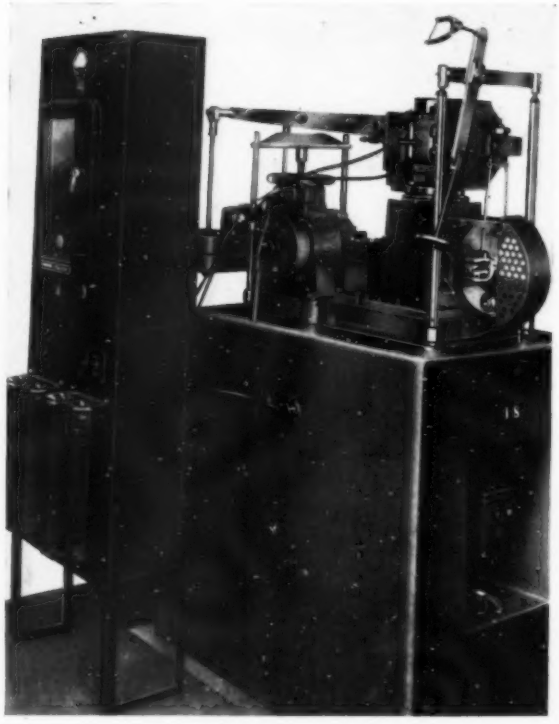
Any physical quantity such as pressure, force, strain, vibration or acceleration can be measured if it can be converted to a voltage signal. Although there are many kinds of pick-up available for this purpose, most of them make use of one of the three fundamental electrical quantities—viz., inductance, resistance or capacity and the voltage signal is obtained by making the phenomenon vary one of these. Other types are electromagnetic, in which an e.m.f. is generated by either a moving coil or a moving-magnet system ; piezo-electric, in which an e.m.f. is developed across a quartz or similar crystal ; photo-electric ; or electronic valve types. No one type has all the advantages without any of the disadvantages and the fact that a particular type has one outstanding advantage often decides that it will be used for a certain application. Various models of the variable capacity, inductance, resistance and electro-magnetic pick-ups will be shown by SOUTHERN INSTRUMENTS, LTD. (C 44).

Reference has already been made to the Drift-corrected Direct-coupled Amplifier developed by this firm for use in strain gauge work. The MR295 Bridge Panel is intended for use with any kind of resistance pressure gauge, unbonded resistance accelerometer or any kind of resistance strain gauge, and it is arranged for use with either single gauges, matched pairs or complete bridges. A four-dial decade arm for use with single gauges is provided, the maximum value being 11,110 ohms. The ratio arms are 2,000 ohms with a 20 ohm apex resistor for use with single gauges or pairs

On Stand C 26, ELLIOTT BROTHERS (LONDON), LTD. will be exhibiting an Electronic Unit for the simultaneous display, on one cathode ray tube, of the strain at 10 different points in a test piece.

A new venture for SCOPHONY-BAIRD, LTD. (C 10) is a range of fatigue-testing machines which are being manufactured in collaboration with the Bristol Aeroplane Company and the National Physical Laboratory. The range at the present time comprises four models operating at temperatures up to 800° C.

All concerned with ensuring dynamic balance of rotating cylindrical bodies will find the Type 1250 Dynamic Balancing Machine exhibited by DAWE INSTRUMENTS, LTD. (C 18) to be of interest. It quickly enables unbalance to be detected and measured directly in units of mass required to restore balance. Further, by the incorporation of a stroboscopic device, the points at which weight correction is necessary are immediately indicated. Assemblies up to 10 lb. in weight can be accommodated and the sensitivity is sufficient to indicate readily an unbalance as small as 5 mg. cm.



Scophony-Baird fatigue testing unit

SCOPHONY-BAIRD, LTD. (C 10) will be showing two Strobo-dynamic Electronic Balancing Machines for use with rotors up to 30 lb. weight in the Mark I machine, and up to 5 lb. weight in the case of the Mark II machine.

Magnetic and Electrical Instruments

On Stand C 61, W. & J. GEORGE & BECKER, LTD. will have a number of electrical and magnetic instruments on show. These will include the Nivoc Precision Magnetometer, designed to meet the demand for an instrument which will perform the usual magnetometer experiments with precision ; Nivoc Unit Resistance Boxes for making up simple and intricate bridge and potentiometer systems ; Nivoc Double-socket Resistance Boxes, in which the socket is made in two parts, insulated from each other, to which the ends of the resistance coils are connected ; and the Nivoc Mirror and Pointer

Galvanometer, a compact and robust yet sensitive instrument of the taut suspension type.

A range of 2½- and 3½-in. round pattern (flush and projecting) and 4-in. square flush pattern switchboard instruments will be exhibited by the BALDWIN INSTRUMENT CO., LTD. on Stand C 5. Portable 6-in. type instruments are also supplied.

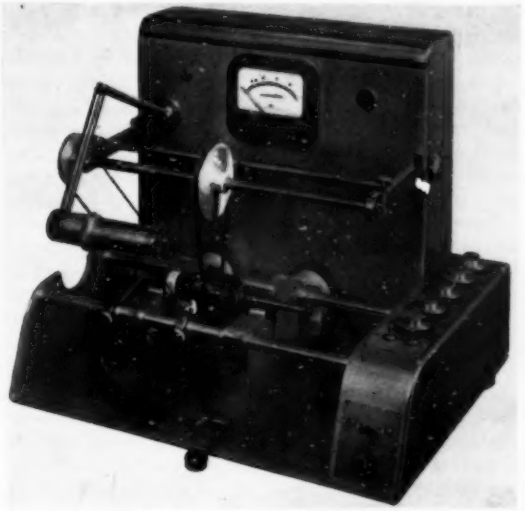
Three general forms of galvanometer are made by this firm: centre-zero pointer type; mirror type; and light-spot type—a self-contained reflecting instrument.

Of universal application to A.C. bridges is the mains-operated Visual Null Indicator which serves bridges over a frequency range of 40 c/s. to 20 kc/s.

For resistance measurements, the "Logohm" Resistance Bridge is a portable, battery operated self-contained instrument including a galvanometer, with a range of 0·05 ohm to 5 megohms. A range of 4, 5 and 6-dial decade resistance units of 0·1, 1, 10, 100 ohms, 1, 10 kilohms, with metal cases for screening will also be shown. The accuracy is ± 0·1%.

The D.C. Potentiometer shown is suitable for educational use and serves many industrial purposes. The range is 1·5 volts and an external battery, galvanometer and standard cell are required.

On Stand H 38, TAYLOR ELECTRICAL INSTRUMENTS, LTD. will exhibit a number of electrical measuring instruments, including a series of Multirange Universal Meters. Models 70A and 75A are robust, sensitive measuring instruments covering all testing, workshop and service requirements. A total of 50 ranges is available on each instrument, the individual ranges differing slightly, and these cover 0–1,000 volts D.C., 0–1,000 volts A.C., 0–500 milliamps., 0–5 amp., 0–10 megohms, and − 34 to + 45 decibels. External adaptors are available to increase certain of these ranges. The Model 85A is a highly sensitive and versatile instrument with 90 ranges covering a wide range of measurements: 0–1,000 D.C. volts, 0–1,000 A.C. and output volts, 0–5,000 volts A.C. and D.C., 0–250 microamps. D.C., 0–1,000 milliamps. D.C., 0–250 microamps. A.C., 0–1,000 milliamps. A.C., 0–10 amps. A.C.



Courtesy of Dawe Instruments, Ltd.

Type 1250 dynamic balancing machine.

Sangamo Weston Model S75 multi-range test set.

and D.C., 0–20 megohms, − 34 to + 69 decibels. External adaptors are available to extend certain of these ranges and to allow measurements of capacity, inductance and voltages up to 10,000 volts A.C. or D.C. The Model 120A is a pocket size instrument capable of measuring 0–2,500 D.C. volts, 0–2,500 A.C. volts, 0–500 D.C. milliamps., 0–200,000 ohms. The Model 125A is also pocket size and can be used for 0–750 D.C. volts, 0–750 A.C. volts, 0–300 D.C. milliamps., 0–15 D.C. amps. and 0–100,000 ohms.

Other instruments in the Taylor range include a mains-operated Insulation Tester, a Megohmmeter and a Capacity-resistance Bridge, Model 110B. The latter is an A.C. mains-operated bridge designed to give quick and accurate measurements of capacity or resistance at mains frequencies. Seven ranges for each, covering 0–1,200 mfds. and 0–12 megohms, should meet all practical requirements. Magic eye indication of bridge balance is incorporated.

One of the most interesting items exhibited by MEASURING INSTRUMENTS (PULLIN), LTD. on Stand C 15 will be a new A.C. Dynamometer Testing Set, Type PD440, which incorporates the well-known Pullin iron-free dynamometer movement and combines the functions of a precision ammeter, voltmeter and wattmeter. There are five ranges of A.C./D.C. volts, from 25–500, and seven ranges of A.C. amps., from 0·5–25, including a 25 milliamp A.C./D.C. range. For power measurement there are 30 ranges from 12·5–12,500 watts. Other exhibits will include an improved model of the Pullin Series 85 Industrial Bench-type Ohmmeter and a wide range of rectangular pattern instruments, comprising 3 in., 3½ in. and 6 in. dial sizes.

The Weston instruments shown on the SANGAMO WESTON Stand, C77, will include Laboratory Standards, Portable Instruments and Panel and Switchboard Instruments. The Laboratory Standards are provided with every essential refinement for measurements of extreme accuracy. Their features include accuracy of 0·1%, 12-in. vernier scales, knife-edge pointers, an anti-parallax mirror, magnetic shielding, a self-contained thermometer, a spirit level and levelling feet. They are available in the moving-coil and dynamometer patterns as ammeters, voltmeters and wattmeters.

Sub-standard Instruments include dynamometer wattmeters, voltmeters and ammeters, moving-iron

instruments and moving-coil types, all with 6-in. scales, whilst the First Grade Instruments comprise moving-iron and moving-coil types. Miniature portable moving-coil types with a 2·6-in. scale are also available.

The Model S.75 Multirange Test Set has 53 ranges and measures A.C. and D.C. current and voltage, resistance and insulation. It is completely self-contained, incorporating batteries to provide power for the ohm range, and a self-contained power pack for insulation measurement at 500 volts. The fully protective safety device fitted is operative for forward or reverse overload.

Panel Instruments covering a wide range of measurements are available in the moving-coil and moving-iron types in round 2, 2½ and 3½ in. flush or projecting bakelite cases, in a 2 in. square flange flush case, or in the horizontal edgewise pattern, whilst Switchboard Instruments with first-grade accuracy include moving-coil and moving-iron types with 6-in. scales in cases for flush or projection mounting.

For operation on currents as low as 5 microamps., sensitive moving-coil Relays will be shown. The miniature moving-coil relay, fulfils the need for a relay which is more sensitive and more accurate than those of the electric-magnetic type but is smaller, lighter and less expensive than the precision moving-coil type.

Elliott Brothers (London), Ltd. will be showing, on Stand C 26, an extremely wide range of switchboard and other types of instruments (with scale lengths from a few inches to 5 ft.) for measuring volts, amps., watts, frequency, etc., including the new styled rectangular instruments. Other exhibits of this type are the Weameter Portable Test Set, a combined volt, amp. and wattmeter for A.C. testing and the New Type 230 recorder of exceptionally robust design.

Further examples of high-quality electrical measuring and recording instruments will be exhibited by Everett, Edgcumbe & Co., Ltd. on Stand C 33, along with a display of process timers and similar types of product.

Temperature Measurement and Control

Although not exclusively a temperature recording instrument, the Elliottronic Recorder exhibited by Elliott Brothers (London), Ltd., on Stand C 26, is eminently suited for this purpose. The instrument operates on the well-known principle of the automatically continuously balanced slidewire potentiometer or Wheatstone bridge, and is designed for use with several types of measuring element. When wired as a D.C. potentiometer it may be used with thermocouples and when wired as a D.C. Wheatstone bridge it may be used in conjunction with a D.C. resistance thermometer. Again, the instrument may be used as an A.C. bridge, for use in conjunction with an A.C. resistance thermometer. In performance the Elliottronic recorder is characterised by the marked superiority of electronic over non-electronic types of instruments—increased accuracy, higher speed and continuous recording. It also has the stability, robustness and reliability associated with A.C. amplifier-operated instruments. The slidewire contact is driven by a robust balancing motor and the pen speed is 3½ seconds for full-scale travel. The instrument is available as either a continuous-writing single-point recorder or as a six-point recorder which provides records of six variables in different colours. The standard speed of operation of the multi-point

Courtesy of Elliott Bros. (London), Ltd.

"Elliottronic" potentiometer recorder.

model is 5 seconds so that each variable is recorded at half-minute intervals. Provision is made in the slidewire unit of the single-point recorder for transmitting an "error" or "deviation" signal, so that this recorder may be used for automatic process control in conjunction with the Elliottrol controller which may be contained in the recorder case or mounted separately, the only link being a twin electrical lead.

Also shown on this stand will be the well-known Elliott optical pyrometer now available with alternative ranges 800°–2,200° C. and 800°–1,700° C.

On the stand of British Electronic Products (1948), Ltd. (H 30) a newly developed Low-temperature Radiation Pyrometer will be shown in operation, this equipment being capable of measuring temperatures down to 150° C. In addition a radiation pyrometer for measuring temperatures from 800° C. upwards will be shown, the unit also being arranged for operating an external circuit at a set temperature level.

Of particular interest to the chemical and allied industries is a new process control system capable of providing very flexible characteristics, having provision for the incorporation of proportional, integral and derivative control functions for stabilization of the system as required. The equipment can be used with various types of measuring devices (e.g., temperature, pressure, etc.), and is arranged to enable the final control operation to suit the controlled process (e.g., valve position, pump speed, etc.). The equipment is also completely unitised and utilises a number of standard amplifier units with associated network units for providing the required characteristics. Tests have already been carried out in industry and the particular version to be shown has been designed for Laboratory work, to provide the greatest possible flexibility in operation with experimental plants.

The British Rototherm Co., Ltd. (C 72) will be showing a comprehensive range of bi-metallic temperature indicators, controllers and recorders. The heavy industrial bi-metallic thermometers are designed for use where robustness is required and include instruments of the co-axial, vertical and flange types, designed to indicate temperatures from —100° F. up to 1,000° F.

Other exhibits will include thermometers fitted with contact heads, to provide accurate on/off temperature control when used in conjunction with a suitable relay; a quick reacting bi-metallic industrial thermometer where robustness and speed of temperature indication is required; and an entirely new design, a heavy industrial bi-metallic thermometer for meeting conditions where more than normal vibration is present.

Of special interest will be two recently developed mercury-in-steel non-indicating controllers in which the mercury switch is operated directly by a Bourdon tube. Both these controllers have a control differential of approximately 5% of the scale deflection and one is fitted with an ammeter and master-control switch.

Rototherm bimetallic temperature gauge.

Besides these two instruments are two indicating controllers operating on the mercury-in-steel principle, both designed to operate within very close limits. Either can be supplied to operate on zero, fixed or variable differential. The non-indicating and the large indicating controllers are for loads up to 3 kW. and the small indicating controller for loads up to 2 kW.

Examples of practically every type of thermometer in use to-day will be seen on the stand of G. H. ZEAL, LTD. (C 8). Thermometer tube blowing represents one of the few remaining hand-skilled crafts, and together with other specialised processes, is carried out by 850 operatives of the firm. The types, patterns and purposes cover the requirements of all the major industries in this country and overseas, and the variety of uses necessitates the production of many thousands of different patterns, each designed for a particular purpose.

Optical Equipment

The exhibits of R. & J. BECK, LTD., on Stand C 13, will include one of particular interest to metallurgists—the No. 50 Universal Microscope for visual, projection and photographic work. As far as possible the instrument is constructed with a minimum of attachable parts. The charge from monocular to binocular vision is made by rotating the two bodies in their turret, and the change from visual observation to projection or photography by a simple movement. In this way rigidity and freedom from vibration are assured.

Other Beck instruments on show will include No. 47 Microscopes for all purposes; No. 48 High Power Binocular Microscopes; low power stereoscopic binocular microscopes; spectroscopes; magnifiers and a projectograph for the projection of opaque objects.

C. BAKER OF HOLBORN, LTD., on Stand C 34, will be exhibiting a full range of their Series 3 and 4 Microscopes and accessories including their well-known Research and Student stands, a new and improved pattern of Stereoscopic Binocular Microscope, a new student model, and the latest development in School Microscopes. The Phase Contrast Microscope and accessories will also be in evidence.

Instruments for the workshop and toolroom will be represented by the Vernier Measuring Microscope and a selection of models adaptable for all purposes with a range of stands and accessories to cover all requirements in microscopy.

In photomicrography it is very difficult to estimate the correct exposure time since this varies greatly with the magnification of the microscope and the camera extension as well as with the density of the specimen. The Microphot, exhibited by the BALDWIN INSTRUMENT CO., LTD. (C 5), overcomes this difficulty by measuring the image brightness in the focal plane of the camera. It consists of a rectifier-type photocell in a suitable mount for placing on the viewing screen and a sensitive light-spot galvanometer.

Inspection magnifiers will form the main exhibit of BRITEX, LTD. on Stand C 40. The new I.C.I. Aspheric Plastic Lens, with its exceedingly wide field of view and a magnification of $\times 2$ or $\times 3$, has been mounted in various ways for operations such as the close inspection of small machine parts. The great advantage of the lens is that it gives binocular vision and enables operators to work for several hours without the least signs of eye strain. BRITEX will also show, by permission of the manufacturers (ENGINEERING DEVELOPMENTS, LTD.) their illuminated mounts incorporating the same lens. In the E.D.M. 105 Illuminated Industrial Magnifier a field intensity of 200–250-ft. candles of substantially daylight colour is provided by the use of a 30-watt fluorescent lamp. Operational discomfort due to heat, usual with filament lamps, is entirely absent.

Other exhibits on Stand C 40 include bench and clamp-type lamps for use with microscopes, and single, double and triple-lens pocket magnifiers.

A range of pocket magnifiers will be shown by NEWBOLD & BULFORD, LTD. on Stand C 12. These will include a folding model with a magnification of $\times 5$ and a lens diameter of 28 mm.; an Aplanatic Magnifier, comprising two 21 mm. plano-convex lenses and a diaphragm, with a magnification of $\times 6$, $\times 8$ or $\times 10$; and a similar magnifier with a folding mount instead of a hexagonal rod handle, in magnifications $\times 6$ and $\times 8$ only.

HANOVIA, LTD. (Stand C 45), the specialists in ultra-violet ray lamps, are showing several exhibits of metallurgical interest, in the form of various lamps for fluorescent tests. The familiar high-pressure arcs, the Fluorescence Lamps, Models XI and XII, which utilise radiation of 3,660 A.U. wavelength, are well known in connection with the identification of minerals. A more direct metallurgical application was recently disclosed by well-known motor manufacturers, who check the de-greasing of metal sheets, prior to processing into car bodies, by a fluorescence test which immediately reveals traces of grease remaining after the detergent wash.

A more recent development is the Detectolight, which is a portable source utilising a radiation of 2,537 A.U. This lamp can be operated either from A.C. mains or from self-contained batteries; it can therefore be used in field work and on mine or quarry faces. This short-wave radiation is particularly valuable for identifying uranium, zinc and other ores, whilst scheelite and other tungsten minerals will fluoresce only in this short wavelength.

On Stand C 32, CHANCE BROTHERS, LTD. will be exhibiting a display of optical glass in the form of slabs, mouldings, colour filter glass, etc., as supplied to the Scientific Instrument Industry. Filter glasses include ON20 heat-absorbing, heat-resistant glass, giving a light transmission of 87% and heat absorption of 8·5% at 3 mm., OB9 colour temperature conversion filter, and neutralising filters ON28–32. Microscope cover glasses, of which Chance Brothers have been the only British manufacturers for over 100 years, and eye-protecting glasses for welders will also be shown.

Photo-electricity.

The photo-electric cells exhibited by MEGATRON LTD. on Stand C 30 will include the Type A and B Selenium Cells previously shown. In addition the new "Megatron Red" cells with two or three times higher sensitivity in the red end of the spectrum will be on view. The "Megatron Pan" cells have a spectral sensitivity somewhat similar to that of panchromatic films and show a response about twice as great to incandescent light as previous types. They are suitable for exposure meters. The "Megatron Infra-Red" cells have a spectral sensitivity extending to beyond 1 μ and have a maximum at 0·8 μ. These cells, combined with the Ilford Infra-Red filter, give an output in response to tungsten light as great as an ordinary type "A" cell without filter.

Other exhibits will include the Megatron type C/L Cosine Corrected Light Meter with two calibrations: 0–0·75 FC, 0–7·5 FC, 0–30 FC, and 0–2 FC, 0–20 FC, 0–100 FC; and the new Megatron Portable Photo-electric Colour Temperature Meter. This instrument is exhibited at the B.I.F. for the first time, and is the first instrument of its kind manufactured in this country. It is used mainly for colour photography and colour cinematography.

The photo-electric exhibits by SANGAMO-WESTON, LTD. on Stand C 77 comprise the Photo-electric Photometer, a pocket size instrument for the measurement of interior illumination, with two ranges, 0–25 and 0–125-ft. candles; the Photo-electric Exposure Meter which has automatic low and high light scales measuring 0–50 and 0–1,600 candles/sq. ft.; and a selection of the new Weston Photo-electric Cells.

Analytical and Vacuum Equipment.

Interest on the Stand of W. & J. GEORGE & BECKER, LTD. (C 61) will this year be centred on their new Aperiodic Balance which will be shown for the first time.

This new balance has a capacity of 200 g. and is sensitive to 0·1 mg. The weights up to 100 g. are applied automatically by means of a weight-change mechanism which is entirely new and extremely simple to use. There are only three dials to operate: one for the 10–90 g. weights (in steps of 10 g.) another for the 1–9 g. series (in steps of 1 g.), whilst the third controls the two ring weights of 300 and 600 mg., respectively. These, together with the 300 mg. scale and 0·1 mg. auxiliary scale, cover the range from 0·1 mg. to 100·1200 g. Provision is made for the addition of a further 100 gm. weight if required. The gram weights, of rhodium-plated brass, adjusted to 0·1 mg., are contained within a dust-proof housing inside the balance case, thus providing a double safeguard against corrosion.

An important feature is that a maximum of four weights only (two only gram plus two fractional ring weights) are in use for the final reading, thus weight errors are kept to a minimum.

An interesting development of this firm is the Nivoc "Kemiframe," a versatile and easily erected framework utilising rods and clamps, which is to the chemist the boon that tubular scaffolding has been to the builder. Other exhibits include the Nivoc Anti-Vibration Table for delicate balances, and the Nivoc Filter Pump, which has a body of phenolic plastic.

Further balances will be exhibited by WILLIAM A. WEBB, LTD. on Stand C 35. Of special interest is a 2,000-oz. Precision Bullion Balance, with a 40-in. triangular girder design gunmetal beam and a sensitivity of 0·005 oz. under full load. At the other extreme will be a 20-g. Micro-chemical Balance with aperiodic action, automatic weight application to 200 mg., and a sensitivity of 0·001 mg.

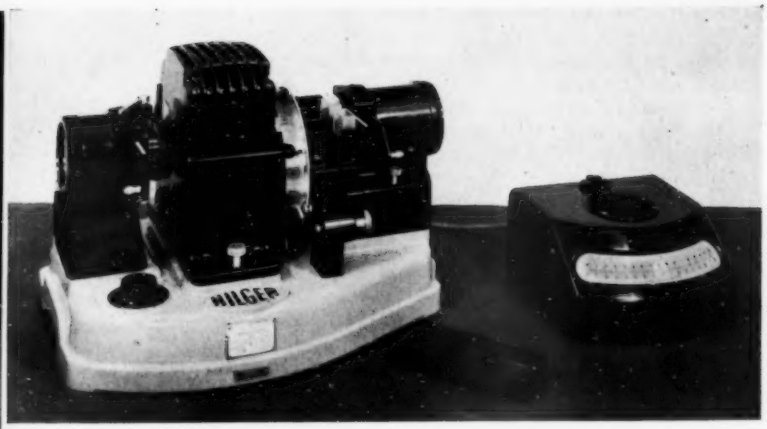
For standard analytical work there will be shown a 200-g. Aperiodic Analytical Balance with automatic weight application to 1 g. and a sensitivity of 1 mg.; a 200-g. Chain-action Analytical Balance; and a normal 200-g. Analytical Balance.

The remarkable increase in the use of colorimetric methods in metallurgical analysis has been due, in no small measure, to the availability of the Hilger "Spekker" Absorptiometer, which will be shown in its completely re-designed form on the stand of HILGER & WATTS, LTD. (C 58). The basic features are maintained; these include mains operation; self-compensation for mains voltage variation through the use of two balanced photocells; lasting accuracy of calibration through the use of an optical mechanical system of measurement; independence of peculiarities or irregularities of the photo-electric circuit through the employment of a null method of use. The newly designed system for controlling the light reaching the photocell allows the scale length to be increased nearly to a complete revolution of the drum and the scale of densities is practically uniform. Owing to this factor and the increased scale length resulting from the increased size of drum, the accuracy is higher than in the most favourable part of the scale on earlier instruments. In order that full use can be made of the increased accuracy of reading, a slow-motion device has been added to the drum and gives positive fine adjustment. The light filters are held in sliding carriers for two filters or pairs of filters, this method enabling rapid alternation or interchange of filters to be effected. Cells from a 0·5 ml. micro size up to one of 4 cm. in length can be accommodated on the standard instrument and long-cell models for weakly absorbing solutions are also available using paths up to 20 cm. in length.

BAIRD & TATLOCK (LONDON), LTD. (Stand C 57) as in former years are exhibiting on a joint stand with other members of Scientific Exports (Great Britain), Ltd. The stand is furnished with B.T.L. metal unit laboratory furniture which is proving more and more popular for certain types of work, and without doubt gives to the laboratory a look of cleanliness and efficiency apart from other functional advantages.

The new B.T.L. Self-balancing Photoelectric Recording Absorptiometer is one of the most interesting exhibits. This instrument, produced in collaboration with the I.C.I., Ltd., to whom much of the development work is due, was required originally to detect small colour changes in a liquor used in a chemical process, and to

Hanovia ' Detectolight '



Hilger H 760 Spekker Absorptiometer.

provide a continuous quantitative indication of these changes on a recorder. With suitable colour filters the instrument may be calibrated to record the composition of any liquid whose absorption can be related to some form of chemical analysis or turbidity.

Other B.T.L. instruments on show are the B.T.L. Bara-Gyro Centrifuge, B.T.L. Wide Range Oven and the Mark I Modified B.T.L. Warburg Bath.

On Stand C 50, EVANS ELECTROSELENIUM, LTD. will be exhibiting two items of interest in the analytical field. The " EEL " Portable Colorimeter, available in mains or battery-operated models, is a compact, portable instrument designed for accurate routine colorimetric analysis and intended for continuous operation. A new instrument on show will be the " EEL " Absorptiometer, a simple yet accurate instrument which is claimed to meet all the requirements of colorimetric analysis. Standard optical cells of any length up to 10 cm. can be accommodated and measurements may be made with narrow band spectrum filters. Mains stabilisation is provided and readings are given on a robust 4-in. meter.

THE TINTOMETER, LTD. have been manufacturing the Lovibond glass colour standards, for all colour measuring needs, since 1885 and on Stand C 63, this company will display a representative selection of their fused optical glass cells for use in colorimetric analysis.

Gas analysts will be interested in Stand C 2 on which GLASS DEVELOPMENTS, LTD. will be showing a new type of Bone & Wheeler Gas Analysis Apparatus. Specially constructed for the Anglo-Iranian Oil Co., Ltd., it incorporates a unique main control stopcock with fast and slow control in the same key, strip-lighted burette, low voltage furnace heating, and a very powerful, demountable hydraulic system.

Produced for the Admiralty Research Laboratory, the Salinity burette shown is designed and calibrated for the accurate determination of the total salts in sea water by titration with standard silver nitrate solution using potassium chromate as indicator.

A selection of vacuum equipment manufactured by W. EDWARDS & CO. (LONDON), LTD. will be shown on Stand C 56 and will include mechanical pumps, diffusion pumps, vacuum accessories and special plants.

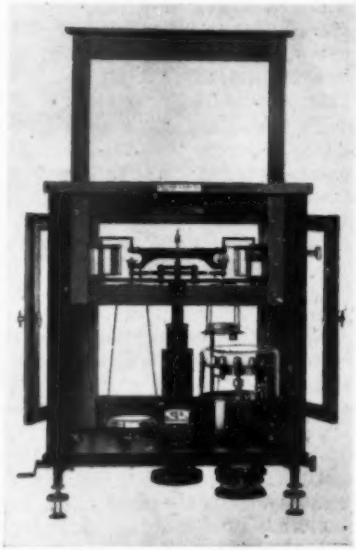
The " Speedivac " range of modern mechanical pumps for general laboratory, pilot plant and production applications are of light-weight construction and have a number of special features including integral spray arrester, oil-level indicator, easy drainage facilities, small oil charge, and quiet valve working.

A wide range of Oil and Mercury Diffusion Pumps with speeds ranging from a few to many thousand litres per second will be shown, including a 16-in. standard four-stage pump for large scale work. These pumps have many special features including integral booster stage and unique design of isolation and baffle valves.

The Edwards range of gauges, including a variety of Electrical (Pirani, Philips, Knudsen, etc.), McLeod and dial-type gauges will be shown, together with a wide selection of metal and glass taps, unions, seals, valves, O-rings, waxes, greases and oils with all other necessary vacuum plumbing accessories for complete vacuum systems.

There will be a number of Vacuum Coating outfits for the Sputtering and Evaporating techniques, from small-scale units for experimental work to high production large capacity plants for industrial work. The new small unit will be of particular interest for College and University work and for shadow casting technique with the Electron Microscope.

This year's " Quickfit " exhibit on Stand



Courtesy of W. J. George & Becker, Ltd.

Aperiodic Balance.

C 87 will catch the eye, especially of those who are not yet *au fait* with full-scale chemical plant in glass. In addition to a comprehensive layout of up-to-date all-glass laboratory apparatus assembled from the ingenious and versatile range devised and developed by QUICKFIT & QUARTZ, LTD., their trademark is now proudly displayed on examples of glass plant which carry the traditions of reliability, quality and interchangeability.

Whilst the industrial exhibits, such as the 100-litre combined reaction and distillation set-up will more easily attract attention, it is probable that readers of this journal will find greater interest in the wide range of laboratory apparatus on show. A considerable number of assemblies will be available for inspection together with some of the new apparatus developed since last year's Fair. The newly featured "Utility" Set, illustrating the versatile unit principles which are fundamental to "Quickfit" equipment will be much in evidence. Quickfit & Quartz claim that their laboratory apparatus is the best in the world and look to the B.I.F. as an opportunity for chemists to challenge the validity of that claim.

Miscellaneous

ACCLES & POLLOCK, LTD. on Stand C 62 will be showing specialised tubing for industrial precision instruments, including laboratory research and medical apparatus.

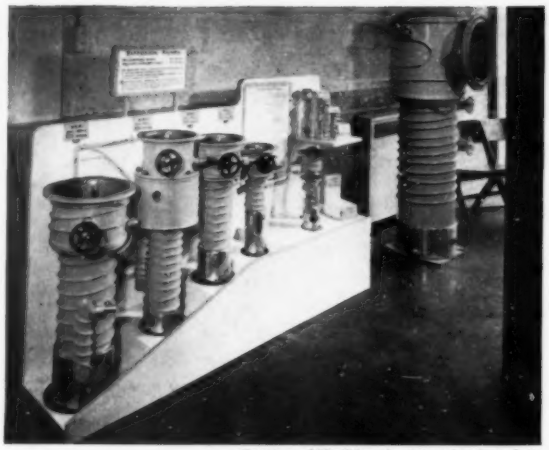
The range covers Bourdon coil tubing; capillary tubing; tubes for instrument pointers; composite tubing—i.e., tubes of two different materials, one tightly drawn over the other; and multibore tubing—i.e., tubes containing more than one hole, for example, one tube with a $\frac{5}{32}$ in. outside diameter contains seven other tubes inside and another tube of $\frac{7}{16}$ in. diameter contains a further 19 tubes inside.

One piece of apparatus to be shown by NASH & THOMPSON, LTD., on Stand C 3, will be of interest to metallurgists. It is a newly developed Plastic Mounting Press for microspecimens. Designed to work up to 6,000 lb./sq. in., it produces Bakelite or transparent mouldings $1\frac{3}{8}$ in. diameter. It is fitted with a 750-watt heater and a cooling coil through which water can be passed. The plunger rises from below into the mould cylinder which, together with the heater and cooling coil, is integral with the body of the instrument. The time required to complete a mould is 4–5 minutes.

The JOHNSON MATTHEY exhibit on Stand B 40 is a departure from the orthodox, situated as it is on the common boundary of the Jewellery and Silverware and Chemicals sections and designed to appeal directly to both. It is impossible—and this is by intent—for a clear dividing line to be found between the jewellery and chemical sections of the stand.

On the one hand, the use of silver by the silversmith and as an electrodeposit in the decorative field is linked to the industrial applications of the metal by a display showing electrodeposited silver in chemical engineering and by one dealing with the development of the company's low temperature brazing alloys from the exceedingly ancient use of silver in alloyed form as a jointing material by the craftsman.

On the other hand, the apparent gulf between the employment of the platinum metals and gold as essential materials in chemical engineering and their use by the manufacturing jeweller is bridged by a display dealing with rhodium as an electrodeposit, in which form it finds extensive use for decorative and industrial work.



Courtesy of W. Edwards & Co. (London), Ltd.

A display of diffusion pumps.

In displaying the products which are for industrial use the examples chosen are principally equipment and materials for the chemical industry, particularly those manufactured of silver and the platinum metals. Prominence is given not only to the many precious metals and precious metal compounds manufactured by the company, but to their very large range of other chemicals, to whose production the metallurgical and chemical skill gained in the manipulation of the precious metals has led. These include a new range of high-purity compounds and metallic elements for research purposes in addition to the established range of spectrographically standardised substances.

The business of THE SHEFFIELD SMELTING CO., LTD. covers a wide range of products. On Stand J 237 the company will demonstrate gold, silver, platinum, palladium, iridium, rhodium, ruthenium and osmium, prepared in a large variety of forms such as sheet, wire, tubing, solders, jewellers' findings, plating anodes, salts, platinum apparatus and thermocouple wires, etc. Special alloys are prepared for deep spinning, stamping and enamelling.

Gold for the jeweller, gilder, dentist, potter, gold beater and others, and platinum for the jeweller and for scientific purposes will be among the exhibits.

The company has specialised in the recovery of precious metals from all types of waste and mining products, for 190 years, and special facilities exist for refining complex mixtures of the platinum group metals. Some of the exhibits will focus attention on these activities.

On Stand C 32, CHANCE BROTHERS, LTD. will include amongst their exhibits the "Flamemaster" Hand-torch for use in light welding and glass working. Weighing only 12 oz., this torch can be used with gas/air or gas/oxygen. Seven interchangeable flame units are available and it has a built-in leak-proof economiser.

COLLIMATOR CASES, LTD. will be showing, on Stand C 36, a selection of cases and woodwork for all types of scientific instruments, manufactured from mahogany, teak and other selected woods. Various designs and finishes suitable for the electrical, medical and scientific instrument trades will be shown. The exhibit will also include a range of high quality leather cases designed for carrying portable instruments, such as surveying levels, test meters, etc., and for similar purposes.

Courtesy of Nash & Thompson, Ltd

Press for mounting microspecimens in plastic.

Airmec R.F. heating equipment.

Several interesting items of laboratory equipment will be shown by TOWNSON & MERCER, LTD. on Stand C 4. The All-Metal Vacuum Desiccator (with glass window) G172 has several advantages over the normal glass unit. The cast aluminium casing, being a better conductor of heat, allows more rapid cooling of hot articles placed in the desiccator; the unit is implosion proof; and the method of sealing by rubber rings is a considerable improvement on the grease method. A development of this unit is the Vacuum Oven, S470, suitable for temperatures up to 120° C. and fitted with Simmestat control.

The T. & M. "Cold" Even Oven is designed to operate at temperatures close to or below room temperature. Besides the normal heater and regulator it is fitted with a cooling coil which is scrubbed by high velocity air from a fan. A further "cold" exhibit is a Refrigerated Brine Supply and Circulator System, S217, for supplying cooling liquid down to 0° C., or even lower, to any external apparatus. For those who find the cost of such equipment excessive, or who have no electrical supply, a Decaloriser is available. This consists of a heat insulated cupboard designed to contain a large block of ice and to circulate the ice cold water from the block round any appropriate apparatus.

For higher temperatures the Research Model Constant Temperature Bath will be shown. This is an exceptionally accurate piece of apparatus with a fine temperature control within ± 0·001° C. for short runs, a stability within ± 0·005°C for 50 hours, rapid recovery from temperature changes, and rapid stabilisation after resetting.

A further exhibit of interest is the T. & M. Silent Shaker fitted with stroboscopic control. This equipment will take loads up to two full Winchesters.

Surface-Tensional Methods for Measuring and Delivering Minute Quantities of Liquids

By G. G. Blake, F.Inst.P., M.I.E.E.

Department of Physics, University of Sydney, Australia.

WHEN conducting micro-analyses the chemist usually prefers to adhere as far as possible to the well-established methods of burette or pipette measurement. There are, however, occasions in connection with various branches of science when only an extremely small quantity of the liquid to be analysed is available. In such circumstances the forces of surface-tension can be utilised in such devices as those described in this paper and the delivery of extremely small and accurately measured volumes assured. Three such surface-tensional devices will be described.

(1) *A device for the delivery of minute volumes of a liquid onto a dry flat surface.* This device was designed by J. T. Stock and M. A. Fill[1] for the delivery of small volumes of liquid, of the order of 1 cu. mm., onto microscope slides or similar surfaces. It consists of two finely drawn glass rods parallel to one another and each ending in a small glass sphere (see Fig. 1.). In order to pick up its charge the device is held in a vertical position and allowed just to touch the surface of the liquid. It is then withdrawn and when both spheres are brought simultaneously into contact with a microscope slide its charge is delivered and it is withdrawn immediately. As shown in Fig 1, the glass handle *H* (which in use is held in the right hand like a pencil) fits tightly through a cork *C*; this limits the depth to which the spheres are immersed. A graph is given by Stock and Fill for depth-of-immersion/delivery in mg., together with a curve showing the effect of duration of immersion upon the quantity delivered.

1 J. T. Stock and M. A. Fill, "A device for delivering small quantities of liquids." *Metallurgia*, June, 1946.

(2) *A device for the delivery of small measured quantities of a liquid as additions to liquids in a container.* This device was devised by the author and is known as a "Dipper." Suitable "dippers" can be made for the delivery of any volume desired from 1 to 10 cu. mm. or more. The 5 cu. mm. dipper here described was designed for use when titrating volumes between 20 and 100 ml. with 0·5 or 1·0 mol. concentrations of reagent.

The titrations were carried out by the author's rectified radio-frequency method of conductimetric analysis [2-6]. Briefly this method is carried out as follows :—

A radio-frequency current is passed through a column of solution contained in a length of glass tube which is fitted on its outside with two metal sheath electrodes which do not come into actual contact with the liquid. The radio-frequency current after modification (in accordance with its resistance) by passage through the solution is rectified and the resultant direct current is measured by means of a zero-shunted micro-ammeter or galvanometer. The relative conductivities of the solutions are obtained from the deflections. A comprehensive account of this method is given in Reference 6.

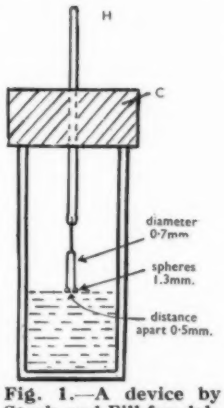


Fig. 1.—A device by Stock and Fill for delivery of small units of liquid onto flat surfaces

The 5 cu. mm. dipper as depicted at *D* (Fig. 2a) consists of a short length of glass tube having an external diameter of 2·5 mm The lower extremity of this tube is sealed in a bunsen flame and finely frosted (this can be done with fine emery cloth) to about one-third of its length. *W* is a wire or rod of any material which fits tightly inside the tube, and is inserted to within approximately 1·3 cm. of the closed end. The exact position of the end of the rod is then adjusted and tests are made until the dipper delivers 5 cu. mm. after insertion and withdrawal from the bottle *B* which contains the reagent *R*.

Calibration is carried out as follows : Employing the author's rectified radio-frequency apparatus, a deflection is obtained first for a 0·2% solution of HCl. This solution is then replaced by a sample drawn from a beaker containing 20 cc. of distilled water. The frosted end of the dipper is next immersed as far as the end of the internal rod *W* in a 1 mol. concentration of the reagent for which its use is intended.

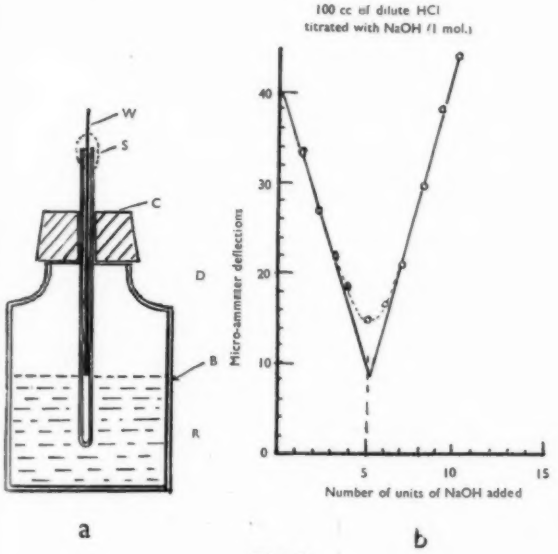


Fig. 2

a.—A "Dipper" for delivering small units of a liquid as additions to liquids in a beaker. b.—A rectified R.F. titration graph for which a 10 cu. mm. "dipper" was employed.

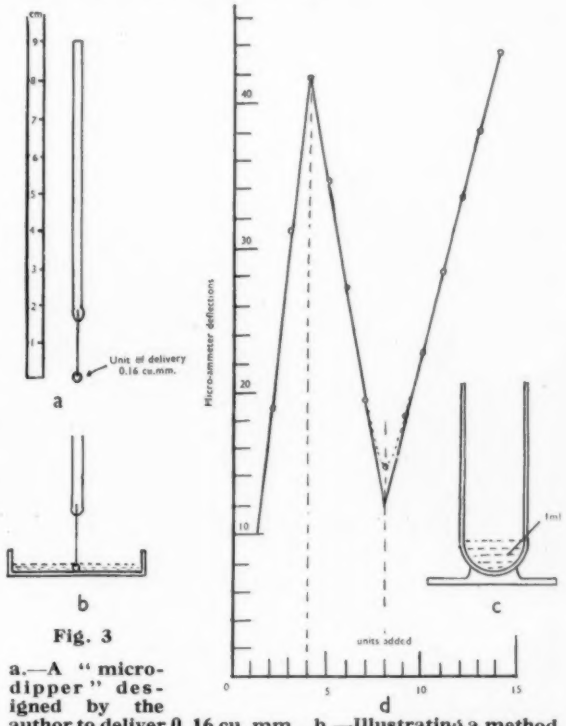


Fig. 3

a.—A "micro-dipper" designed by the author to deliver 0.16 cu. mm. b.—Illustrating a method of picking up a surface-tensional charge. c.—A beaker containing 1 ml. of distilled water to which micro-deliveries are made. d.—A micro-titration graph for a solution of HCl, first compounded and then titrated by a 0.5 mol. solution of NaOH in 0.16 cu. mm. units.

Note that the addition of four such units to 1 cc. of water gave a deflection of 42 micro-amps. and at this point on the graphtablet the NaOH titration was commenced. The exact position of the neutral point was discovered by extrapolation.

After removal it should now deliver approximately 5 cu. mm. of the reagent each time it is stirred in the 20 ml. of water in the beaker. It should be wiped dry every time it is removed before it is replaced in the reagent (a piece of clean lint or filter paper is convenient for this purpose.) When four such units have been added, if the calibration is correct, the deflection registered will be the same as that originally observed for the 0·2% solution. If the deflection is too large or too small, the depth of immersion must be readjusted and another four dipper units must be added to a fresh 20 ml. of water.

After several readjustments and repetitions of this process exact calibration is soon achieved. Finally the internal rod *W* is fixed permanently in position by sealing it to the top of the tube as indicated at *S*. It is very important that the dipper be kept clean and free from grease as even a touch from the operator's fingers is liable to make the deliveries unreliable.

Both speed and accuracy of measurement are greatly facilitated if a limit is set to the possible depth of immersion of the dipper. This is achieved very simply by inserting the latter through a large cork *C* which rests on the mouth of the bottle *B* which contains the reagent.

In order to allow for differences in the viscosity and surface tension of different solutions a separately calibrated and labelled dipper should be employed for each reagent.

Fig. 2b is a sample titration graph for a solution of HCl titrated by 1 mol. NaOH. For this a dipper delivering 10 cu. mm. was employed (this has a slightly larger diameter than the 5 cu. mm. dipper already described).

The good alignment of the deflections indicates the accuracy obtainable by this method. It will be seen from the graph that the 100 ml. solution titrated contained 5 units, i.e., 50 cu. mm. of HCl.

(3) *A device for the delivery of minute measured quantities for ultra-micro analysis.* The dipper shown in Fig. 3a, which is drawn to scale, consists of a frosted glass sphere (not much larger than the head of an average pin) attached to the end of a short length of platinum wire.

In order to limit its depth of immersion in the reagent it has been found a good plan to place the latter in the bottom of a *flat* glass container as in Fig. 3b. There should be just sufficient liquid to cover the glass sphere when it is placed in the liquid and in contact with the bottom of the container.

Fig. 3c, also drawn to scale, shows 1 ml. of liquid in a very small beaker. as employed when the graph Fig. 3d was plotted (by R.R.F. conductimetric analysis). Four micro-dipper units of 0·5 mol. concentration of HCl were added to 1 ml. of distilled water and the deflection obtained was 42 micro-amp. The solution thus compounded was then titrated by adding NaOH (0·5 mol.) in similar dipper units. The accuracy of this acid-base determination can be judged by the graph. The dipper employed delivered 0·16 cu. mm.

The value of this unit is arrived at by the following method: A deflection is first obtained for a weak concentration of solution containing a known quantity *a* cu. mm. of a 1 mol. solution of the reagent for which the micro-dipper is intended. A number of micro-dipper units of 1 mol. solution is then added say to 1 cc. of distilled water until the same deflection is obtained. The cubic delivery capacity of the dipper sphere then $= \frac{a}{x}$ where x is the number of units added.

Graphtablet. When a large number of acid–base determinations are to be made the author has found it convenient to cover a sheet of squared paper marked with ordinates and abscissae with finely frosted glass. If pencil is used it can be erased with rubber.

2 G. G. Blake, "Conductimetric analysis at radio-frequency," *Journal of Sci. Instr.*, **24**, April, 1947.

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